Pit and Quarry

With which is consolidated CEMENT-MILL & QUARRY

Member Audit Bureau of Circulations

Read in Largest Number of Plants

Vol. XXII September 9, 1931 No. 12

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Published bi-weekly on Wednesday for producers and manufacturers of Cement, Crushed Stone, Gypsum, Lime, Sand, Gravel and other nonmetallic minerals. Entered as second-class matter October 9, 1928, at the Postoffice at Chicago, Ill., under the Act of March 3, 1879.

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Vol. XXII CHICAGO, SEPTEMBER 9, 1931 No. 12

Huge Cement Merger Is Pending in Britain

WILL CONTROL 70% OF TRADE

Through the proposed acquisition of the "Red Triangle" or "Allied" group of companies, the Associated Portland Cement Co. of London, England, will obtain control of approximately 70 per cent. of the British cement trade.

The total capitalization of the Allied group is £5,392,596 ($26,200,000) and the proposed purchase price is £2,025,000 ($9,850,000.) The Associated's present issued capital is £5,319,720 ($25,800,000), divided into 3,000,000 common shares of £1 each and 2,319,720 preference shares of a similar denomination. To finance its purchase the company proposes to offer 500,000 new £1 common shares at par to shareholders with the right to take up one new share for every six now held. Arrangements also have been made to sell £150,000 5½ per cent. second debenture stock and £180,280 5½ per cent. £1 preference shares. On completion of the purchase, a further £750,000 5½ per cent. second debentures will be issued.

One Dead, 4 Injured in Premature Quarry Blast

Charles Pauquette, one of the members of the blasting crew of the Michigan Limestone & Chemical Co., Rogers City, Mich., died from injuries received in a premature explosion at the company's limestone quarry recently. John Schlager was seriously injured. Theodore Haselhuhn, Leo Paull and Cyrus Bessie received only minor bruises from flying stone. The accident is the only one of its kind to happen since the company started operations in 1912, during which time millions of tons of rock have been shot down.

Bleaching and Filtering Clay Produced at Plant

On Aug. 1, the Oloncha Mineral Products Co. of Los Angeles, Cal., put into operation its new plant for the production of bleaching and filtering clay. The raw material is quarried at Oloncha, 100 mi. northeast of Los Angeles, and shipped to the plant by rail. Deposits of more than 4,000,000 tons have already been tested.

The plant is of modern design and construction, using in its process a swing-hammer pulverizer for primary breakage, a 5-ft. by 40-ft. rotary drier, three vibrating screens and cyclones for separation, and a hammermill for final reduction. The plant has a capacity of 3½ tons per hr., but is so designed that its capacity can be doubled on short notice. Already the plant is operating on two 8-hr. shifts to keep up with the demand. The product is used principally for bleaching vegetable and mineral oils.

Quarry Avalanche Saves Drilling, Blasting Cost

It is unusual to have a "fortunate accident," but the Asbestos Corp., Ltd., of Montreal got a lucky break at its Beaver, Ont., pit just recently.

A large tonnage of rock, loosened by heavy rains, slipped from the face of the pit, which was not being worked at the time, and therefore caused no injury to workers.

Officials of the Asbestos Corp. say that mining operations at the face where the slide occurred had been discontinued two years ago as operations prior to that time had undermined the wall and made it unsafe. It would have been necessary to trim the face before operations could have been resumed and plans for taking down the upper sections of the wall had already been considered. The earth overburden had already been removed preparatory to commencing this work.

The natural fall made available a large amount of broken rock amounting to approximately 150,000 tons, and has made drilling and blasting unnecessary.

River-Sand Plant Under Construction at Topeka

The Victory Sand & Stone Co. is rapidly completing the construction of a new sand plant at Topeka, Kan., of which M. M. Small will be manager. Sand will be pumped from the river by a 120-ft. dredge. The plant will have a pumping capacity of about 20 carloads per day, and a loading capacity of about fifty cars a day.

Cement Probe Pushed by Trade Commission

SEEKS ANTI-TRUST VIOLATION

Manufacturers and state highway commissions have been asked to supply the Federal Trade Commission with "certain information" in connection with the commission's inquiry into competitive conditions in the cement industry. The inquiry seeks to ascertain whether activities of trade associations, manufacturers of cement or dealers in cement constitute violations of the anti-trust laws.

No other information as to the progress of the investigation was obtainable from the commission, except that field work also was in progress. The commission resolutely adheres to a policy of secrecy concerning investigations it is conducting unless and until it reaches a point where prosecution can be instituted.

The commission also has sent to cement manufacturers a schedule asking for costs and profits. This, however, is not in connection with the cement investigation, but is part of a general study the commission is making into the establishment of base prices of various commodities.

Another interesting inquiry the commission is carrying on is that into the building-material industry. Cement will be an incidental commodity to be studied in this investigation.

Official announcement from the commission said that this inquiry was to "investigate and report facts relating to the letting of contracts for the construction of government buildings, particularly with a view to determining whether or not there are or have been any price-fixing or other agreements, understandings, or combinations of interests among individuals, partnerships or corporations engaged in the production, manufacture or sale of building materials with respect to the prices or other terms at or under which such material will be furnished contractors or bidders for such construction work."

Chief Examiner H. L. Anderson, of the commission, is in charge of the investigation.

It was said at the commission that it has not yet been decided whether field investigators will be sent to any particular production points in the building-materials investigation.

Files Reply to Trade Commission Protest

CLAIMS GYPSUM IS FIREPROOF

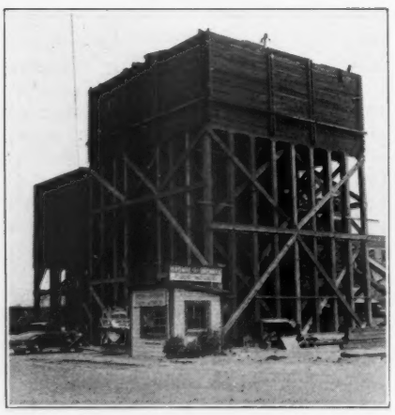
The United States Gypsum Co. has filed its answer to the complaint heretofore made against it by the Federal Trade Commission for advertising certain of its products as fireproof and as being rock products. The answer sets out that gypsum is a hydrous calcium sulphate, which is incombustible and fireproof; that it is mined or quarried just as any other rock and that the manufactured products complained of in fact contain all the qualities of the original rock, and, like the rock from which they are made, are incombustible and fireproof. In the answer it is further shown that, since the inception of the gypsum industry, gypsum materials have been known as rock products and have been advertised as fireproof by the entire industry.

The commission apparently intends to object to the practice of the gypsum industry of so advertising its products. The trade has always treated gypsum products as rock products. That gypsum is incombustible is equally well recognized. It is difficult to see how the advertisement of these qualities by the industry can be deemed unfair competition.

Frisco Gravel Producer Building Concrete Plant

The Bode Gravel Co., distributor of aggregates in San Francisco since 1915, is building a new central-mixing concrete plant which promises to be one of the most advanced operations of its kind. This plant, which will be capable of producing 125 cu. yd. of concrete per hr., will be in operation about Sept. 1. It is located at 225 Alabama St., San Francisco.

This plant has many unusual features some of which are new to this field. The plant structure is 83 ft. in height and has a storage capacity of 24 cars of aggregates and 1,500 cu. ft. of cement. Aggregates will be unloaded from cars to track hoppers, which will feed to the storage bins by belt conveyors. Cement will be received in bulk in car-loads and will be handled by a Fuller-Kinyon portable unloader, either to storage over the plant or to a 15,000-cu. ft. ground storage tank.



The Bode concrete plant under construction.

Eight sizes of aggregates, water, and two kinds of cement will be stored. These will be measured or weighed automatically by an electrical device which will record all measurements. A printer in the dispatcher's room will record all measurements on a tape and on the delivery ticket. All operations will have auxiliary hand controls for emergency use. This system is expected to remove the element of human error from the measurement of the concrete mix.

Henry Bode and one of the trucks used to carry concrete.

The materials will be mixed for about 10 sec. in a Rex 1-cu. yd. mixer, just long enough to shrink the mix. The concrete will then be discharged to a 3-cu. yd. batch hopper which feeds to the truck mixers that finish the job of mixing. Norris K. Davis and Rex Motomixer trucks are to be used.

The Interstate Granite Corp. of Charlotte, N. C., has let the contract for erection of a plant on Hutchinson Ave., Charlotte, to cost about $100,000.

Shovel operating in the Sugar Creek quarry.

Shovel Climbs Steep Ramp from Quarry in High Gear

E. F. Armbrust operates the Sugar Creek Stone Quarry at Washington Court House, O., producing a good grade of hard limestone for road-building and general construction.

The stone is so thinly-stratified that, when shot down from the quarry face, the breakage is sufficient so that practically all of it can be handled by a power shovel. For handling this material, Mr. Armbrust recently purchased a Michigan shovel, manufactured by the Michigan Power Shovel Co. of Benton Harbor, Mich. This shovel, shown in the accompanying view in operation at the Sugar Creek quarry, has full-circle loading, three-quarter digging, with no tail swing. The power plant is stationary and the machine is crawler-mounted for ready portability.

At such times as the shovel is not needed for work in the quarry it is used to load from stock-piles located at ground level. A short, steep ramp is used to ascend from the quarry and the incline is negotiated by the Michigan shovel—in high gear—without apparent effort.

Alpena Gravel Co. Plans Plant to Cost $100,000

Plans for the erection of a $100,000 sand-and-gravel plant at Millersburgh, Mich., are being prepared for the Alpena Gravel Co. of Alpena, Mich., according to press reports.

Northwestern Portland Moves Seattle Offices

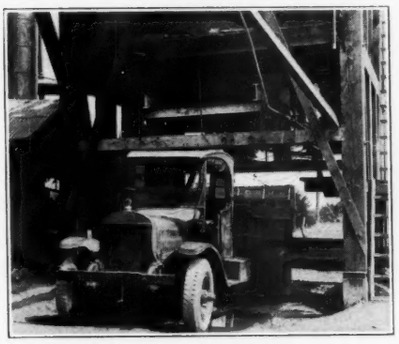
The Northwestern Portland Cement Co. has moved its Seattle, Wash., offices from the Dexter Horton Building to the Northern Life Tower.

Coast Dealer Builds Batching-Plant Unit

AGGREGATES BOUGHT LOCALLY

The Hayward Building Material Co. of Hayward, Cal., recently installed a new sand-and-gravel batching plant to meet the growing demand for this material. The company operates a building-material yard and formerly sold all its aggregates directly from storage bins, loading trucks in two tunnels under the bins. Now a conveyor operates in one of these tunnels carrying material from the bins to a six-compartment storage bin over the batching plant which has a total capacity of 50 cu. yd.

Six air-operated sliding gates feed the aggregates into a 2-cu. yd. weighing-batcher which discharges to trucks below. The air-gates and batcher were furnished by the Norris



Truck loading under the air-controlled weighing batcher.

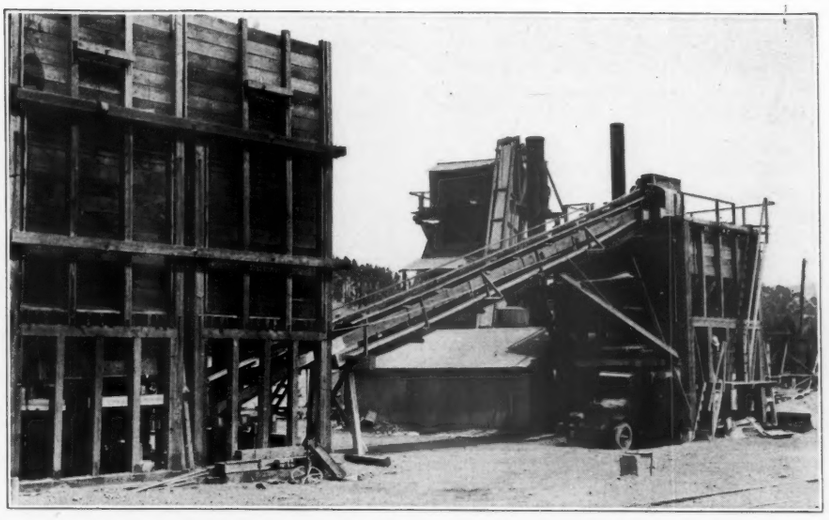
K. Davis Co. The batcher has a Fairbanks 2-beam scale and a telltale dial. The conveying equipment was furnished by the Bodinson Mfg. Co. The company operates a road-gravel plant at Decoto, but buys all its concrete gravel from local producers.

Asks Reconsideration of Rates on Cement Tiles

The Federal-American Cement Tile Co., Hammond, Ind., has asked the Interstate Commerce Commission to reöpen for further hearing or reconsideration its Investigation and Suspension Docket 3,130 (Part 2) in so far as it concerns rates on concrete slabs between points in the southwest.

In its decision in that case, which involved rates on many commodities between points in the southwest and between the southwest and various other parts of the country, the commission found that the rates proposed by the railroads on concrete slabs had been justified. Maximum reasonable rates on that commodity would be column 17½, with a minimum weight of 60,000 lb. per car, the commission found.

In its petition, the Federal-American company took exception to the commission's finding of justification for the proposed concrete-block rates,



The Hayward batching plant. Gravel storage bins at left.

which were higher than the rates on articles in the brick list.

It pointed out that, since the hearing in the suspension case, the list of articles taking brick rates within and to southern territory and within and to Mississippi Valley territory had been amended to include concrete slabs. This action was undertaken voluntarily by the carriers, the petition said.

The commission based its decision chiefly on the fact that concrete slabs, generally, were of a higher value than other articles on the brick list, declaring that "on this record there is no warrant for the conclusion that slabs should move at brick rates."

Exception to this statement was made in the Federal-American's petition, which said there were many articles included in the brick list "having values many times that of slabs, that these articles are there by orders of the commission or by voluntary action on the part of the respondents."

The Federal-American admitted that the average value of concrete slabs might be slightly higher than the average value of some of the articles in the brick list. It said, however, that "there is nothing in this record to justify the enormous spread between 12 per cent. and 17½ per cent. of the first-class rates."

Cement Official Attacks Proposed Rate Increase

An increase in freight rates on cement not only would not stimulate cement traffic on the railroads, but would divert a substantial portion of the traffic now moving by rail and would lessen the length of the haul on the traffic retained by the railroads, F. E. Paulson, vice-president, Lehigh Portland Cement Co., told the Interstate Commerce Commission Aug. 18 during the hearing on the railroads' application for a 15-per cent. increase.

He told the commission of the establishment of cement silos at or near many of the large cities of the country and remarked that these silos have localized cement distribution and have made it difficult for the long-haul producer shipping by rail to compete.

Within a 50- or 60-mile radius of the source of supply, whether this is the mill or silos, he said, there is the keenest kind of competition between rail and truck transportation for the cement business. He said it was impossible to draw a conclusion as to the general level of trucking rates as compared with rail rates because of the diversity of trucking conditions and the wide range of trucking rates.

Mr. Paulson added that a study by his company in official territory had indicated that within a radius of 50 or 60 mi. the ruling level of trucking rates approximated rail rates.

Any increase in freight rates from the Lehigh district, he said, would force his company to utilize the idle capacity of its Buffalo mill and use the water route to New York city.

The witness said that, if the increase were granted, there was a possibility his company would develop its plant at Alsen, N. Y., and use the Hudson River to get its cement to New York. This would require a capital expenditure, he said, but was an "eventuality."

New California Gravel Plant to Raise Output

A new plant was recently put into operation under rather unusual circumstances by the Texas Rock Asphalt Co. near Cline, Tex. The plant was started early in June and was practically completed when the company bid successfully on a large road contract. The plant has been operating at capacity since early in July and will complete this contract about Oct. 1, at which time the finishing touches will be put on the plant. Over 1,000 tons of rock asphalt are now being shipped per day. The new plant replaces the old plant which the company had operated since 1924.

Urge U. S. Projects Use American Cement

CONGRESSIONAL ACTION SEEN

Some action by the next session of Congress to prohibit the purchase of foreign-made goods by American quartermasters and other purchasing agencies of the government located outside the continental limits of the United States, unless there is some excellent reason for the purchase, is regarded as likely. This belief arises from publication of presumably reliable reports that the Army has bought some 50,000 bbl. of foreign-made cement for use in construction projects in Panama. The last Army appropriation bill carried a provision making it mandatory on purchasing agents of that branch of the government to buy their supplies of American manufacturers, unless there was some very good reason, such as obvious superiority or much greater price advantage.

This provision, it is believed, is now being interpreted by some as not applying to Army purchasing agents located outside the continental limits of the United States. It is well known that constructing quartermasters in foreign posts of the Army always have had considerable latitude in writing their specifications and in the purchase of their materials. The fact that the "American-made products" clause of the last Army appropriation bill is being interpreted by some of them as not applying has resulted in a demand in some quarters for a clarification of the law by Congress. It is certain to be brought to the attention of Congress.

Investigation has revealed that the 50,000-odd bbl. of cement involved in the Panama case would not come under the provisions of the "American-made" clause anyhow, because it was contracted for prior to July 1, 1931, when the law became effective. Regardless of this, however, it was pointed out that the cement was bought with money furnished by American taxpayers and that, if it was at all possible, the Army should have bought at least a part of the cement from American producers. Though the law became effective July 1 it was adopted by Congress last winter and the agitation for the purchase of American-made products was started even before that.

While the Panama situation certainly does not involve any violation either of the letter or spirit of the law, certain American manufacturers, not only of cement, but of steel and other products which have been bought from foreign lands, are known to feel that in cases of this character the government purchasing officers are morally bound to buy from American manufacturers, if at all feasible. For this reason, they are preparing to present the situation to Congress. It likewise has been pointed out that the Navy at present is engaged in large construction projects in Hawaii and that it has purchased American cement and other building material for use there. If the Navy can do this, why shouldn't the Army and other branches of the government?

American manufacturers are not grieving so much over materials which have been purchased in the past, but they are known to be concerned with those which may be bought in the future, particularly in view of the present condition of most industries, which need all the encouragement possible.

N. Y. Trap Rock Offices Moved to 230 Park Ave.

The New York Trap Rock Corp. announces the opening of its new offices in the New York Central Bldg., at 230 Park Ave., New York, N. Y. Also occupying the suite are the corporation's affiliates, the Carbonate of Lime Corp. and Hudson River Shipyards Corp.

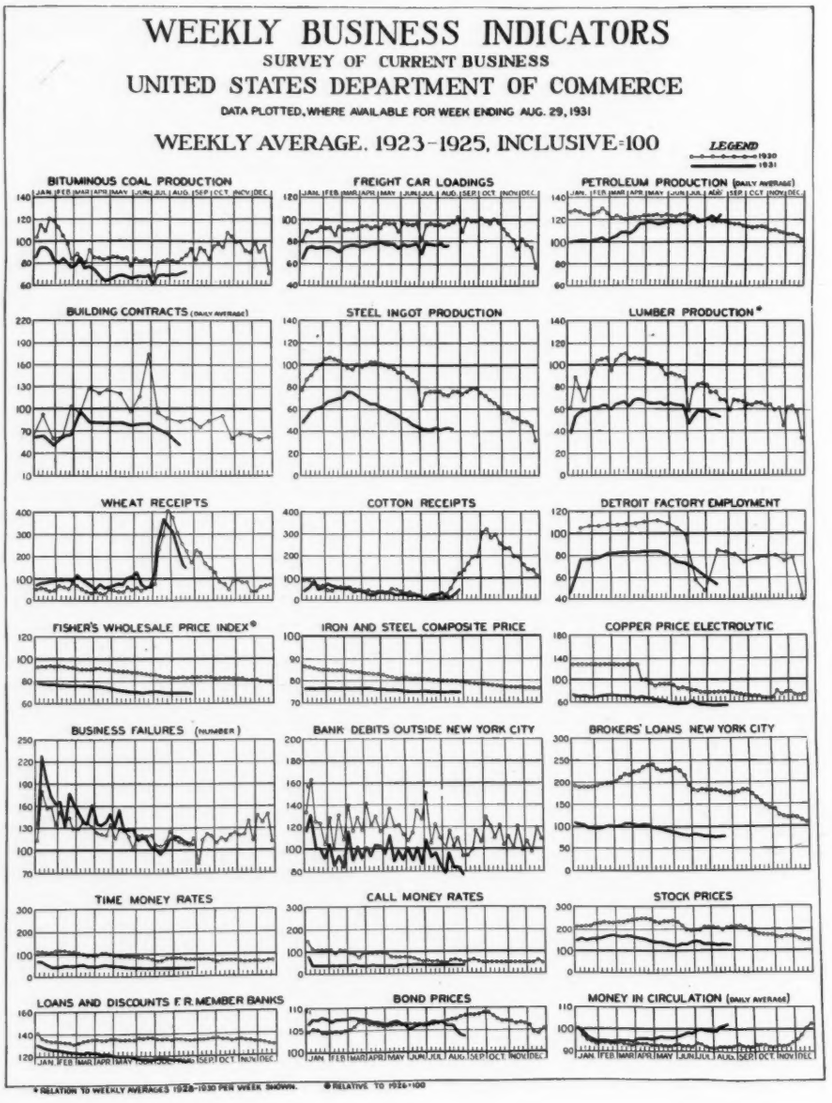
Stone Resembling Relief Map of Wisconsin Found

An odd rock formation, resembling closely a relief map of the state of Wisconsin, rivers and all, has been found near the Eureka locks on the upper Fox River, nine miles northeast of Berlin, Wis.

It was called to the attention of Maj. Harry M. Trippe, district federal engineer who during an inspection trip visited the lock site which is nearly 60 years old. The locks were constructed of limestone quarried in that vicinity. One of the workmen explained to Maj. Trippe that when the large stone bearing resemblance to the state was brought to the locks site it was decided not to use it in the dam because of its unusual formation.

The stone is more than a foot thick and several yards in circumference. Its shape tallies almost exactly with that of the state, even to having the Wisconsin and Fox rivers in relief.

Local officials contemplate erecting the stone on a pedestal as a monument.



Southern Plants Hit by High Freight Rates

SHORT LINES ASK REDUCTION

Because producers of sand, gravel and crushed stone located on so-called short or weak railroad lines in southern territory have been badly hurt by the increased freight rates they were required to pay as a result of the revision in rates on those products prescribed by the Interstate Commerce Commission (Docket 17,517), the American Short-Line Railroad Assn., has appealed to the commission for a rehearing of the case.

The commission's order permitted the weak lines to add an arbitrary of 25 c. per ton to the through rates on sand, gravel and crushed stone, the arbitrary to accrue solely to the weak line. In other instances the commission required a higher scale of rates for movements requiring the use of more than one railroad. The result was that producers on the short lines, who competed with those located adjacent to the single through lines, were placed at a disadvantage.

The short-line association pointed out that some of the weak lines in the south were dependent on revenues derived from the movement of sand, gravel and stone and, in some instances, that traffic constituted more than 70 per cent. of their entire business.

Some producers located on the short lines have been compelled to go out of business, the short-line petition said, because of the rate inequality created by the commission's order.

"Your petitioner is prepared to show that additional deposits of these materials have been discovered on the lines of some of the short or weak lines," the petition said, "and it is impracticable for these deposits to be developed under the present rate adjustment and thus these short or weak lines are being deprived of badly-needed revenue."

In conclusion, the short lines asked the commission to revise the present scale and prescribe a "merged scale" of rates which would be the same for both single- or joint-line application.

Meet Oct. 13 to Arrange Gravel Convention Show

Exhibit plans for the 1932 convention and show of the National Sand and Gravel Assn., to be held at Pittsburgh, January 27 to 29, will be formulated at Cleveland, O., on October 13 when the Manufacturers' Division of the association will meet.

BUILDING-MATERIAL PRICES, AUGUST 1, 1931

Data collected by the Bureau of the Census and prepared by the Division of Building and Housing, U. S. Bureau of Standards.

City	Portland Cement (bbl.)	Gypsum Plaster (ton)	Gypsum Plaster Board (1,000 sq. ft.)	Hydrated Lime (ton)	Building Sand (cu. yd.)	Crushed Stone (ton)	Roofing Slate (100 sq. ft.)
Akron, O.	$1.74	$14.00	$.....	$12.00	$1.50	$2.50	$12.00
Albany, N. Y.	2.34	17.10	24.75	15.75	1.85	1.85	.....
Atlanta, Ga.	2.20	15.00	35.00	12.50	2.50	2.50	.....
Baltimore, Md.	2.20	15.50	25.00	13.00	1.85	2.50	10.00
Buffalo, N. Y.	2.95	16.00	21.00	18.00	2.50	2.05	12.00
Cincinnati, O.	2.14	.....	22.75	14.40	2.63	2.55	.....
Cleveland, O.	1.68	15.00	.....	10.00	1.69	2.15	16.00
Columbia, S. C.	2.00	14.40	35.00	11.00	1.25	2.75	15.00
Columbus, O.	2.35	14.40	.....	12.00	1.50	2.75	14.00
Des Moines, Iowa	2.00	15.00	25.00	15.00	1.65	3.50	15.00
Detroit, Mich.	2.60	13.00	25.00	16.00	2.60	2.75	.....
Erie, Pa.	2.00	16.00	22.50	16.00	2.00	.....	.....
Fairmont, W. Va.	2.80	18.00	35.00	16.00	3.00	3.50	13.00
Grand Forks, N. D.	2.60	19.00	.....	25.00	2.60	.....	.....
Haverhill, Mass.	2.60	18.50	25.00	18.00	.....	.....	.....
Kansas City, Mo.	1.80	15.00	25.00	.....	1.70	1.88	17.00
Lansing, Mich.	2.25	16.00	.....	.....	2.10	.....	.....
Los Angeles, Cal.	2.30	15.20	23.50	24.70	1.85	1.90	.....
Louisville, Ky.	1.86	17.00	.....	15.50	2.00	2.15	15.00
Milwaukee, Wis.	1.48	15.20	22.00	14.00	1.35	1.35	.....
New Bedford, Mass.	2.80	16.50	24.00	16.50	1.75	2.75	.....
New Haven, Conn.	2.70	.....	.....	19.00	1.25	2.25	.....
New London, Conn.	2.60	18.00	25.00	18.00	1.50	3.00	.....
New Orleans, La.	2.20	18.00	.....	14.00	1.80	.....	11.00
Paterson, N. J.	2.20	17.50	24.00	18.00	1.50	2.10	12.00
Philadelphia, Pa.	2.16	17.50	.....	14.50	1.75	2.60	11.22
Portland, Ore.	1.90	19.80	33.00	22.00	1.30	1.90	.....
Poughkeepsie, N. Y.	1.95	.....	.....	.....	.....	2.00	.....
Richmond, Va.	3.10	20.00	31.00	17.50	1.95	2.45	13.00
Rochester, N. Y.	2.28	16.00	22.00	20.00	2.25	2.40	12.00
Rockford, Ill.	2.00	16.00	25.00	20.00	1.40	1.15	.....
St. Louis, Mo.	1.85	18.00	.....	18.00	1.35	1.30	13.00
St. Paul, Minn.	2.15	17.00	24.00	17.00	1.40	2.08	13.00
Saginaw, Mich.	1.61	18.00	24.00	16.00	2.25	.....	14.40
San Antonio, Tex.	2.43	19.15	40.00	20.00	2.25	2.35	16.50
San Francisco, Cal.	....	16.90	45.00	19.50	1.40	1.60	15.00
Scranton, Pa.	2.60	19.00	.....	20.00	3.25	.....	.....
Seattle, Wash.	2.40	18.00	40.00	22.00	1.40	1.90	.....
Shreveport, La.	3.20	22.00	.....	.....	2.00	.....	15.00
Sioux Falls, Ia.	2.40	15.50	.....	24.00	1.25	2.25	.....
Syracuse, N. Y.	2.16	15.00	25.00	13.00	1.80	1.70	13.50
Tampa, Fla.	2.60	20.00	.....	24.00	.....	4.00	.....
Terre Haute, Ind.	2.25	18.00	28.00	18.00	1.25	3.00	13.25
Toledo, O.	2.20	15.70	22.50	16.00	2.00	2.25	.....
Trenton, N. J.	2.20	17.50	23.00	18.00	1.50	2.15	9.80
Tucson, Ariz.	3.37	17.00	40.00	30.00	1.25	2.25	.....
Tulsa, Okla.	1.90	16.50	22.50	22.00	.85	2.35	.....
Washington, D. C.	1.78	16.00	25.00	13.00	.....	.....	.....
Waterbury, Conn.	2.60	20.00	30.00	20.00	1.25	2.45	15.00
Wichita, Kan.	1.60	15.00	.....	26.00	1.00	.....	.....

Speeds Deliveries to Farmers with Trucks

SPURS AGSTONE SALES VOLUME

"We will deliver your agricultural limestone in two hours," was the statement made recently to a farmer at the office of the Carbon Limestone Co., Youngstown, O., by Phillip Heim, sales manager.

The farmer who wanted the agricultural limestone lives 30 miles from Youngstown and 18 miles from the Carbon Company's plant.

"Here's the way the Carbon company worked out a system of rapid delivery service," Mr. Heim explained.

"First, we made a canvass of farmers in a radius of 25 miles about the plant. We found they would welcome rapid service. So loading bins and scales were installed at the plant to take care of trucks.

"Business increased and our radius spread until now we deliver in a 50-mile radius. Before the advent of the trucking system, many farmers bought their agricultural limestone in sacks. The sacks cost $1.50 a ton, so the new system means a large saving to farmers.

"And, of course, the trucking system made it possible to deliver 5, 10 or 15 tons to the farmer just when he wants it. The farmer has no unloading to do. The trucks drive right into the field where the spreader is working. Some is dumped right in the spreader. The rest is piled for immediate use.

"Perhaps the farmer has half finished applying limestone to his field. A rain sets in. He must stop. He simply telephones and postpones the order until the weather clears.

"In the old days when agricultural limestone was shipped by rail, it was much harder to handle. First, it had to be taken when the car came in. Second, it had to be loaded, hauled and unloaded and then loaded again when the field was ready for spreading. It often took days to do this work. Our company's trucking system saves the farmer days of toil," Mr. Heim declared.

But the farmer was inquisitive about all this. "How do you manage to keep trucks enough at distant points along rail routes to take care of that business?" he asked.

Mr. Heim explained. "We took both Pennsylvania and Ohio and marked them out into territories. Then we located an agent in each district. Usually an outstanding citizen of the territory was selected. These agents provide the trucks.

"In addition the company keeps a fleet of 17 trucks that are available for agents to use. Quick service is assured by rail with such trucking transportation facilities at the destination. Our traffic department traces every car shipped until it reaches the buyer."

Editorials

Stability in Profits

WE strongly suspect that much of the pessimism current in business circles to-day is due to a false basis of accounting, as the result of which some producers whose business is in a seemingly poor condition are really making a rate of profit comparable with the average of the last five years. There are many businesses, judging from many reports to stockholders, which are showing only 3, 4 or 5 per cent. profit on the invested capital, whereas the adoption of a sounder accounting policy would raise this rate to normal levels.

Let us assume, for example, a crushed-stone plant which represents a book value of $200,000 and whose profits are running at the rate of $8,000 a year, and that there are plenty of plants in a similar relative position is only too well known by all types of nonmetallic-mineral producers. The return is at the rate of 4 per cent. The book value is arrived at by taking the cost of the plant erected at peak prices and scaling it down year by year to allow for the factors of depreciation and obsolescence. According to the system of accounting followed, this typical plant is making what its owners call a miserable showing. The same plant can be built to-day for less than $125,000 which represents, therefore, its true present value at current prices. If the book value of the plant were marked down to this figure, as should be done, the present earnings of $8,000 would show a return of 6.4 per cent. and everyone would be satisfied. False accounting can easily be responsible for the difference between pessimism and optimism, and one need not know very much about general accounting methods to realize that this false basis of evaluating plant investment is the one commonly employed.

Profits should be based on the current replacement value of the physical assets of a plant at the time at which the profits are made. In some cases, as at present, this policy will require the radical marking down of assets that were acquired at peak prices, and to many operators this will seem to be the equivalent of taking a huge and unwarranted loss. It should, however, be borne in mind that large book values, unless they represent present-day values, are fictitious and dangerous. Under present conditions they needlessly lower the profit rate and bring some concerns, which are financially sound, down to the class of profitless enterprises. Businesses in need of capital are judged by their earnings rather than by their physical valuations, and the more stable the rate of earnings the more attractive the investment of capital appears to the stock- or bond-buyer. If the value of the physical assets is adjusted each year to conform to their replacement costs, earning rates will show more stability. According to the accounting practices of most operators, physical assets show a high degree of stability inasmuch as they are affected mostly by the slow operation of the depreciation and obsolescence factors, but the profit rate fluctuates with every up and down in the sales curve. Under a sounder plan the physical assets would be adjusted each year—upward, if the replacements values were higher; and downward, if they were lower (as at present)—while the profit rate would remain fairly stationary. Consistent dividends would be more common and there would be less dissatisfaction among stockholders in times of slackened business.

The uncertainties of every type of business are greatly increased by the fact that the rate of the return on capital follows too closely the fluctuations of the sales curve, and anything that can be done to flatten out the inequalities of the profit-rate curve will inevitably tend to alleviate the serious mental depression caused by sharp ups and downs in stockholders' incomes. Stability is the crying need of business to-day—stability in prices, stability in earnings, and stability in the profit rate. The policy of adjusting physical book values to agree with current replacement costs, together with the adoption of 5-year or 10-year averages as the basis of sales comparisons, will accomplish much in softening the otherwise inevitably sharp fluctuations in the profit curve.

Silicosis

THE frequency and size of numerous recent damage awards, made by juries for injuries caused by silicosis alleged to be due to exposure to silica and other dusts in stone quarries, have presented a new and serious problem. The problem is new only in the sense that it has recently assumed threatening proportions and it is serious because every adverse decision adds weight to the mass of precedent already established. Decisions awarding heavy damages to quarry workers who have developed silicosis, or what is claimed to be silicosis, as the result of their occupations are based on the common-law and statute obligations of the employer to provide wholesome working conditions for his employees, but, as in all similar cases, unscrupulous employees falling in the hands of equally unscrupulous lawyers can quite easily succeed in exacting a heavy and unjustified toll from the industries affected. The fact that the burden is at present being carried by the insurance companies does not appease the employers, for insurance rates have already been raised to indemnify the insurance companies against their unusually heavy losses and the companies may even refuse to insure silicosis risks.

The dangers of silicious particles when taken into the lungs are only too real and this fact has been recognized by governments in the enactment of legislation holding the employer responsible for the damage caused. Silicosis is a form of pneumoconiosis caused by the inhalation of silica dust. Its symptoms are the growth of fibrous tissues in the

lungs and a gradual loss of lung function. Pulmonary tuberculosis is usually the ultimate development. The great danger lies in the fact that the type of dust which produces this form of tuberculosis, or miners' phthisis, is made up of minute particles, say from 5 microns downward in size, and these may not be visible or noticeable to the senses and they may be present in an atmosphere quite damp.

Mechanical means for the control of silica and other dusts should do much to relieve the situation, which not only places a heavy financial burden on industry but exacts a toll in human lives. Existing appliances may not succeed in providing complete and satisfactory control in all cases but they certainly reduce the hazards and so place a check on the rising tendency of insurance costs. From that point of view the cost of their installation can often be justified, and whatever shortcomings present-day apparatus may have are certain to be overcome by further improvements.

A movement to organize producers of products in whose processing silica dust is an unavoidable by-product has already been set on foot and in so far as it promises to do constructive work deserves the support of every interested operator. Producers are interested not only in escaping the unwarranted suits of dishonest claimants but in discovering means for reducing the silicosis hazard to negligible proportions. A strong organization, working in conjunction with the engineering branches of the equipment industry and those who have made a diligent study of the disease and its causes, should be able quickly to show some worth-while progress in meeting and solving a problem that may otherwise get out of hand.

A Valuable Service Withdrawn

FOR a long time producers of sand and gravel and crushed stone have been able to watch the movement of sales in their business by means of the weekly reports of car loadings released by the Car Service Division of the American Railway Association. These reports have furnished the only regular and dependable source of information concerning production and they have been very valuable guides to producers in the fields involved.

Unfortunately the railways have decided to withhold this information and for some time their reports of car loadings have grouped nonmetallic minerals with the products of other industries under a classification called "Miscellaneous." To producers in the industries affected, this represents a step backward, since it buries, along with the products of many industries of much less importance, the output of industries whose shipments, expressed in car-loads, rival those of some industries and exceed those of others whose shipments are reported in detail. It would seem that interest in detailed car-loading reports should vary in proportion to the number of car-loads shipped by various industries and, therefore, that only the smallest industries having the smallest total shipments should be included under a "miscellaneous" heading. For some reason the railways have seen fit to eliminate detailed reports for the huge nonmetallic-mineral industries, while they publish full information about industries which, as has been said, do not use as many cars and, by that token, may be assumed to have less interest in detailed reports.

Nonmetallic-mineral producers placed a high value on the association's car-loading reports in so far as they affected their industries, and the decision to cease publication of them will be felt as a distinct loss. The decision is particularly unfortunate, in our opinion, because it comes at a time when the railways are seeking a considerable rise in their rates and need the support of every type of industry and especially that of those which use many thousands of cars every month and which can, if pressed, turn much of their tonnage to other means of transport.

Prolonging the Life and Lowering Upkeep Costs of Excavators

In the operation of a shovel-crane-drag-line powered by an internal-combustion engine, there are four things which will materially prolong the life of the machine, increase its efficiency and reduce its maintenance cost, according to G. H. Olson, of the Link-Belt Co. They are simple things, which every operator should know, but many fail to carry out in the every-day routine of running a machine.

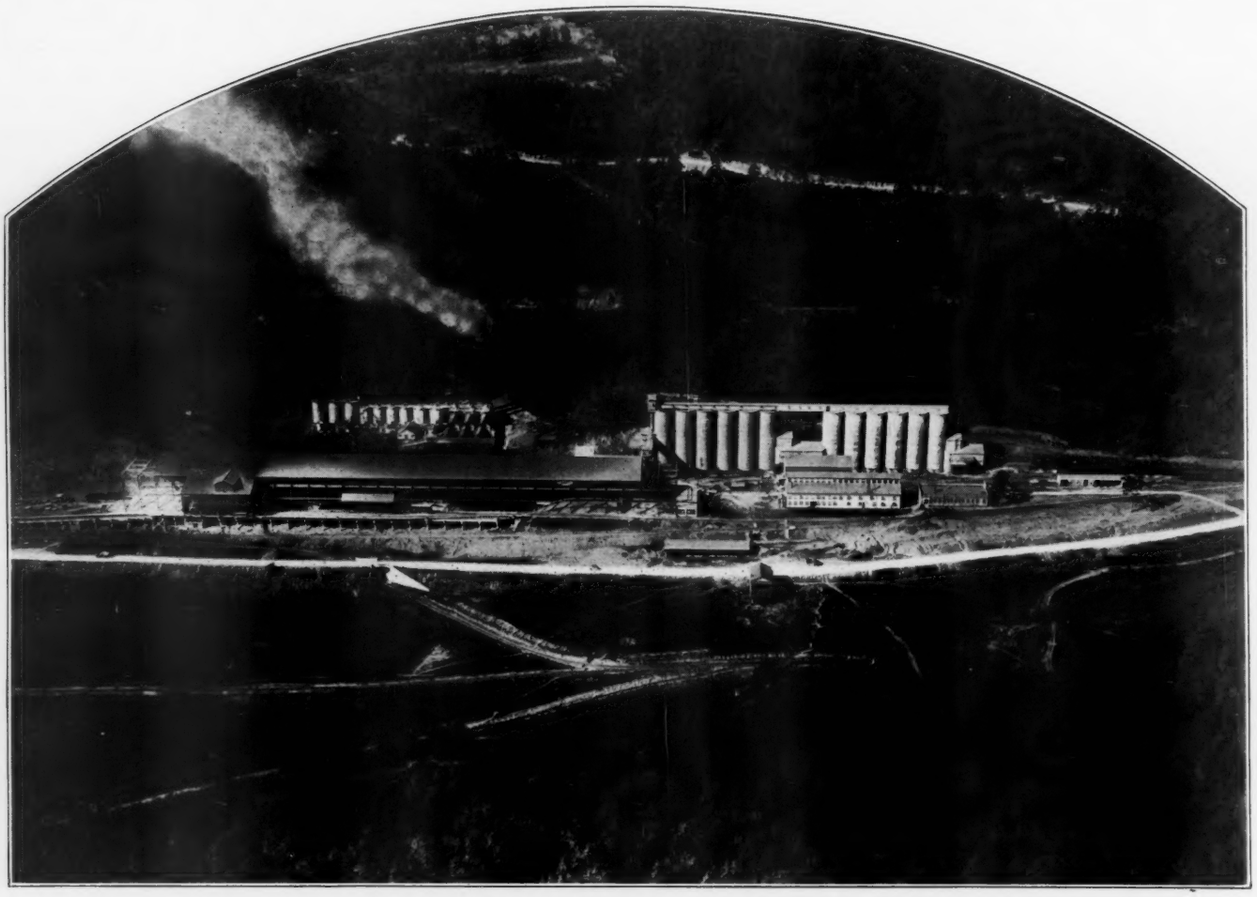
The following suggestions should be pasted inside the cab of the machine, and a definite maintenance schedule should be carried out.

1. *Cleanliness.*—Keep your machine and its parts clean and well painted. It will inspire pride in your machine and make it easier to care for.

2. *Good Fuel.*—Use good fuel and keep it perfectly clean. It will increase the life of the engine and give a more dependable power-plant for your work. Do not permit your fuel to be stored or handled in any way that is likely to introduce water or dirt.

3. *Lubrication.*—Lubricate the machine properly, using the correct grade and kind of lubricant for each requirement. Lubricate often enough and carefully, but at the same time wipe off any excess oil or grease, as otherwise dirt will cling to it, creating an unkempt machine. Depending upon the amount of service the machine is called upon to perform, regulate the lubrication periods, but do not try to stretch the intervals by putting on twice as much grease or oil at a time. If you do not have a lubrication chart, write to the manufacturer of the machine for one.

4. *Mishandling.*—Exercise care in handling the machine. Do not abuse or break it up by abnormal operation, when a little care will avoid it. In shovel work, do not try to move a whole mountain in one dipperful, but strike the proper combination of cutting depth and height, and maintain it. It will be easier on the operator, easier on the shovel, and more yards of excavation will be moved.



The Signal Mountain Portland Cement Co. plant as seen from the air. Road in background leads to the top of the mountain.

Historic Signal Mountain Yields Stone for Chattanooga Cement Plant

Open Quarry Abandoned in Favor of Tunnels; Third Kiln Increases Capacity

By MAT F. BEISBER

SIGNAL MOUNTAIN is a southern byword in more ways than one. As the name of a mountain it is linked with Tennessee history and no visitor to Chattanooga fails to visit or have it pointed out to him, thanks to the ever-enthusiastic boosters of that city. To the southern cement industry "Signal Mountain" has a meaning of no less importance, as the cement mill of that name at the base of that famous mountain holds a key position in the South.

Cement was first produced at this location in 1923, when the Signal Mountain Portland Cement Co. placed its two-kiln, wet-process plant in operation. At that time 3,000 bbl. of cement was its daily capacity. With a realization of the possible need for additional capacity to keep pace with the rapid development of the territory which it serves, the original plans provided facilities for a 4-kiln plant—double the capacity of the two units first installed. Hardly three years passed when this foresight on the part of the Cowham Engineering Co., Chicago, Ill., designer and operator of the project, was justified and a third 175-ft. kiln was added, increasing the daily capacity to 4,500 bbl.

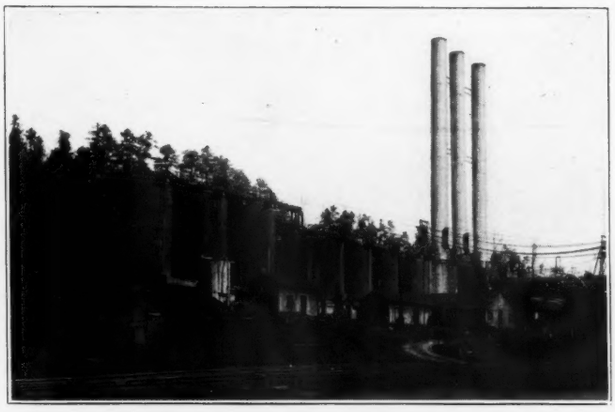
In the eight-year history of the mill, this expansion is undoubtedly the most important of its many improvements. With the kiln was added a hammermill to increase the rock-crushing capacity, and two additional Compeb mills were installed in both the raw- and finish-grinding departments. With the increased productive capacity additional storage facilities were provided by the construction of a six-silo unit having a capacity of 90,000 bbl.

More recent among the developments in this plant is the complete change made in its quarrying methods. After seven years of open-bank quarrying, tunnels are now being driven into the face, affording entries into what will become an extensive undercover mining operation. The need for this change is accounted for by an increasing height of

overburden which made further progress into the face highly expensive.

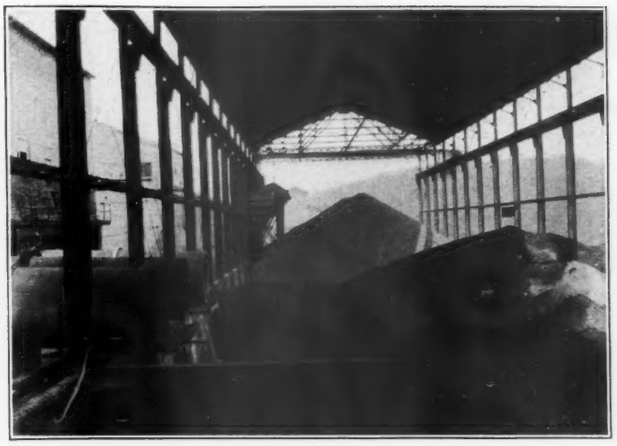
Three tunnel entries were made into the face from the quarry-floor level, which is the surrounding ground level. The roof of the new entries was selected as that of sharply-defined seam at a height of approximately 50 ft. above the quarry floor. Two of the tunnels relatively close together have roofs 56 ft. and 54 ft. high, respectively, and the third, located some distance away, has a roof 42 ft. high. At the time of the writer's inspection, work had progressed in No. 1 tunnel to a distance of 300 ft., in No. 2 to a distance of 300 ft. and in No. 3 to a distance of 225 ft. All tunnels are approximately 50 ft. in width.

With roofs more than 45 ft. in height and spacious widths within the tunnels, standard-size shovels operated with ease and extensions of the quarry tracks allow the former quarry cars to transport the blasted rock. This unusually fine loading facility is enhanced by the freedom from elevating or hoisting the rock or cars to the ground level.



Slurry tanks with kiln stacks on right.

Drilling and blasting operations on the tunnel faces are based on standard header and bench methods, there being a header 12 ft. high at the ceiling, blasted out first, and by three benches, each approximately 12 ft. high. The header is driven forward about 14 ft. at a time by a series of wedge cuts made by three wedge and two side shots. Each wedge contains eight drill holes and is shot separately. The drilling equipment consists of Gardner-Denver and Chicago Pneumatic Tool Co. drifter drills for the header work and standard rock drills for the bench holes.



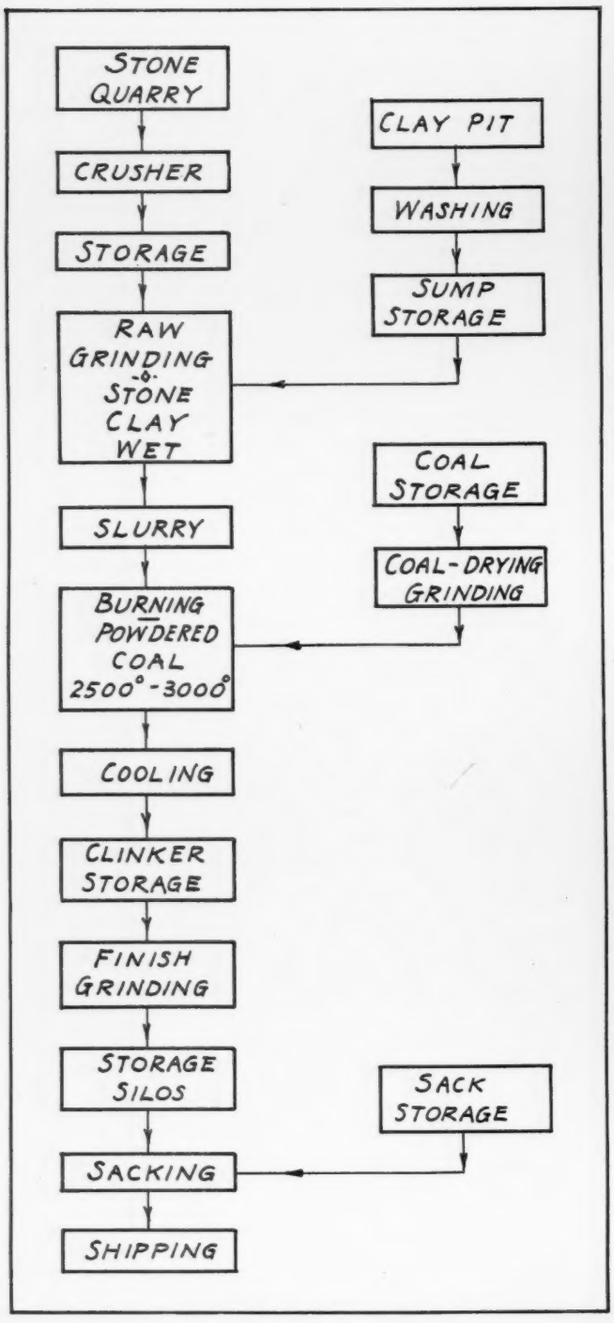
The clinker storage. Coolers on left; coal storage in right foreground.

For loading the blasted rock a Marion type 450 1½-cu. yd. shovel and a Bucyrus 50B 2-cu. yd. shovel are provided. In the mine-to-plant transportation system there are 25 Easton 12-ton steel cars with 3 steam locomotives, one of which is a Porter fireless type employed in the tunnels.

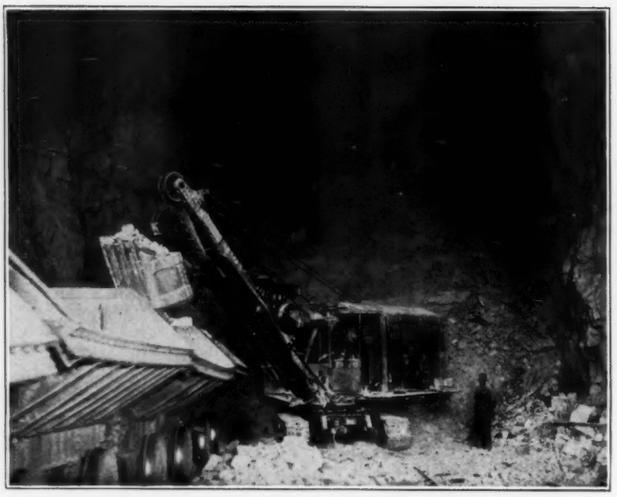
Taking the mill as a whole, the outstanding feature is the simplicity of design. The Cowham Engineering Co., as independent engineer, chose high-grade machinery for each phase of the operations and this accounts, in a large measure, for the efficiency of the plant.

A single building for raw-material storage—800 ft. in length and 80 ft. in width—interconnects all departments except the cement-storage. Along one side of this building are located four departments, each receiving or discharging its materials from or to stock-piles within. These departments are the raw-grinding, the coal-drying and coal-pulveriz-

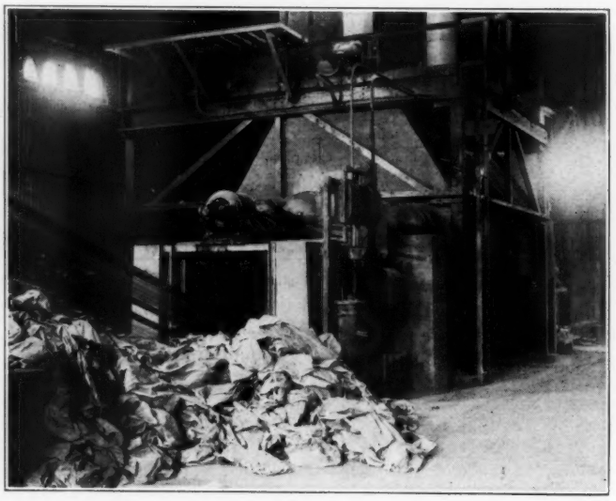
The Signal Mountain quarry, showing the three new tunnel entries.



Flow-sheet of operations.

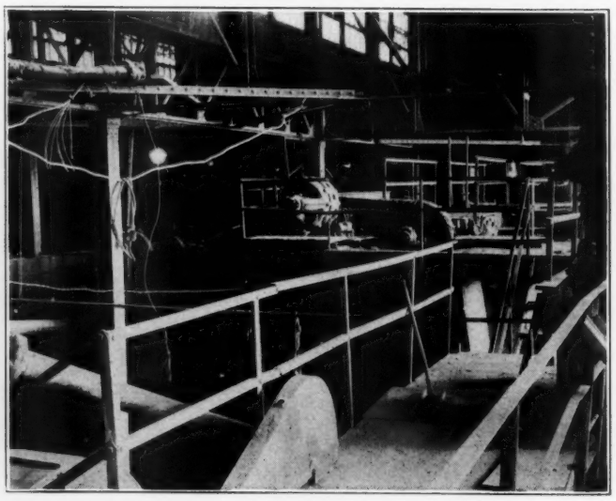


Loading cars in tunnel with a standard-size excavator.

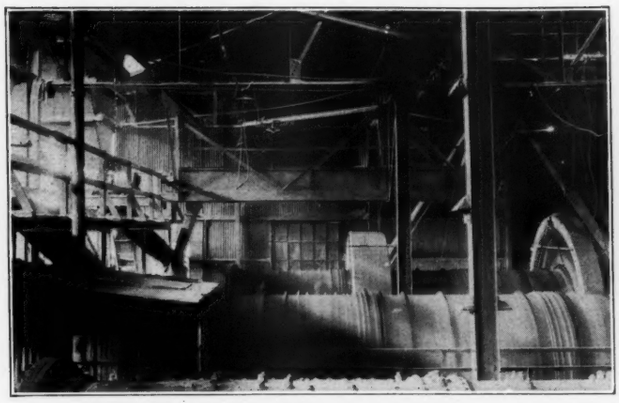


Cleaning machine in the sack department.

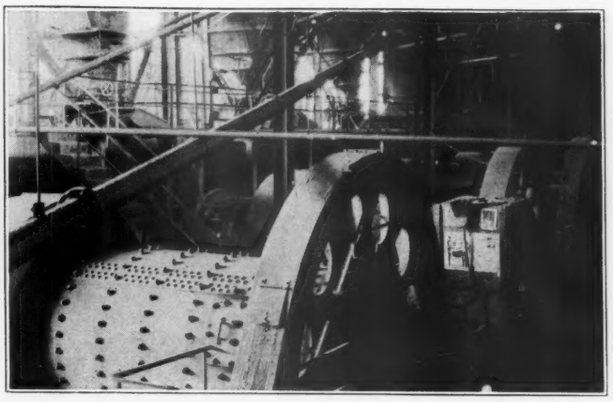
View of materials-storage building from highway.



Mud-mill at right; storage tank at the left.



Finish-grinding mills. Air-separation apparatus at upper right.



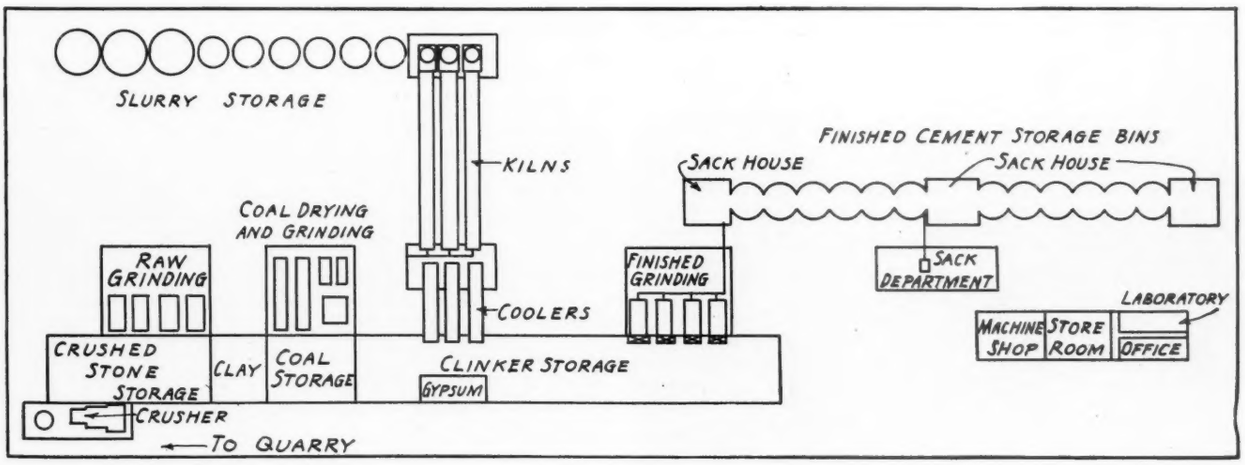
The raw-grinding mills; feed hoppers in background.

ing, the clinker-cooling, and the finish-grinding. On the opposite side toward the quarry is the crushing department, served by a track from the quarry and clay pit. Another track, connected with the yard service tracks, is mounted on concrete bents along the building, and provides facilities for the unloading of cars carrying gypsum or coal. Some idea of the enormous capacity of this building can be gained from the fact that it provides storage space for 160,000 bbl. of clinker, 18,000 tons of crushed rock, 8,000 tons of coal, 6,000 tons of clay, and 1,100 tons of gypsum. Sufficient clinker is stored to supply the finish-grinding department for a month.

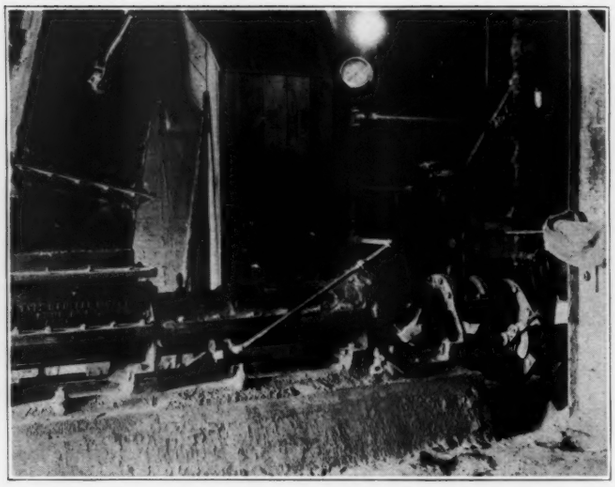
Cars of rock from the quarry are dumped directly into the crushing chamber of an Allis-Chalmers No. 21 gyratory crusher, which reduces the material, at the rate of 160 tons per hr., to minus-8-in. size. The discharged material from the crusher is received by a Chain Belt continuous bucket elevator with 60-in. by 12-in. by 21-in. buckets, which elevates it to two overhead bins, which supply the two Williams No. 6 Jumbo hammer-mills. Each of these mills is equipped with its own feeder and both are mounted at the wall of the storage building which at this point is about 20 ft. above the ground level. The discharge from the hammer-mills—minus-¾-in. crushed rock—falls directly into the open rock-storage area, where a Shepard 6½-ton traveling crane transfers it to large stock-piles as required. The crushing machinery is driven by the following motors: A 200-hp. unit for the gyratory, a 75-hp. motor for the pan conveyor, a 150-hp. motor for each of the direct-driven hammer-mills and a 5-hp. motor for each of the hammer-mill feeders.

Stone storage with raw-mill hoppers on right, hammer-mills on left.

In the storage building, directly in front of the raw-grinding department, is a group of 4 raw-mill feed-hoppers which are kept full of crushed rock by the traveling crane. A continuous feed to the



Lay-out of the Signal Mountain cement plant.

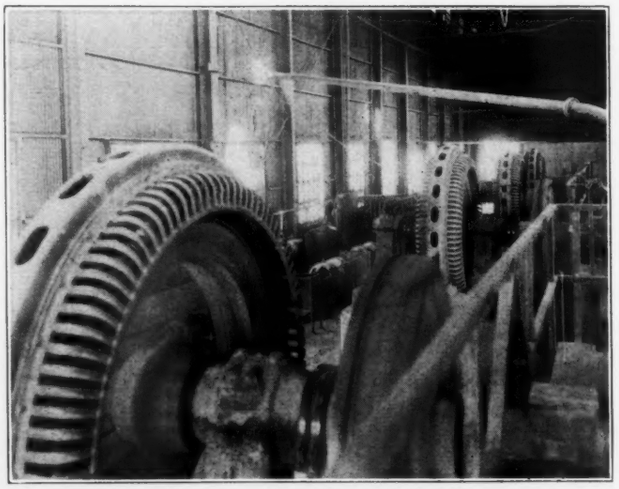


Cement-pump installation in No. 1 packhouse.

One of the slurry-pump installations.

mills is provided by means of a F. L. Smidth bucket-type feeder installed on each unit. Four Allis-Chalmers 2-compartment Compeb mills form the nucleus of this department. Two of the mills are 7-ft. by 22-ft. units and the other pair—installed with the third kiln in 1926—are 7-ft. by 26-ft. units. All are driven by Allis-Chalmers 500-hp. synchronous motors through Cutler-Hammer magnetic clutches. As the wet process of grinding is employed, water and clay in solution are added, the clay being supplied by a "mud mill." This unit consists of two circular concrete tanks, the first equipped with a plow-type agitator for the production of the solution (clay being supplied by a chute from the storage building), and the second tank is an agitated-storage tank which acts as a feeder for a Morris centrifugal pump. The latter delivers the clay solution to a feeder-tank over the mills. Excess from the feeder-tank returns by gravity to the agitated-storage tank.

Slurry from the mills is discharged into a single trough which is equipped with two screw agitators. The sump supplies a Morris 4-in. slurry-pump which sends the liquid to a relay tank 11 ft. in diameter and 10 ft. high. Another Morris slurry-pump delivers the slurry to any of the seven slurry-blending tanks. As seen from the plant layout, the slurry-tanks are located perpendicular to the kilns near the stack end. The original units consisted of four 20-ft. diameter by 25-ft. high concrete tanks each of which has a rated capacity of 840 bbl., and two 25-ft. diameter by 33-ft. high tanks of 1,210 bbl. capacity. The tanks, nearest the kilns, are used for the kiln feed. With the expansion program of 1926,



Synchronous-motor drive on grinding mills, showing magnetic clutches.

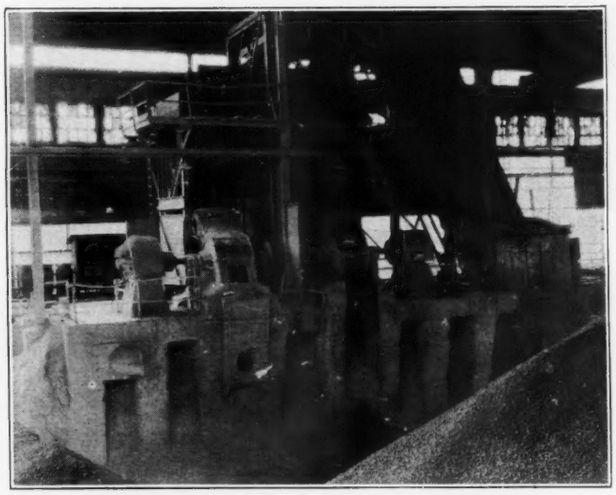
Slurry tanks, showing agitator drive. Kilns at right.

three more blending tanks of somewhat larger capacity were added. They are 30 ft. in diameter and 33 ft. high and hold 1,745 bbl. of slurry each. Mechanical agitation is provided for each tank through bevel-gear-driven paddles supplied with power from two shafts, one for the three large tanks and the other for the six small tanks. Each shaft is driven by a 30-hp. motor. The slurry flow from the blending tanks to the kiln-feed tanks and from the latter to the Ferris-wheel kiln-feeders is provided by Morris pumps. All the slurry pumps are of the same size and are driven, either direct or through belts, by 40-hp. motors.

Slurry is burned to clinker in three Allis-Chalmers 11-ft. by 175-ft. rotary kilns which are fired by

pulverized coal. Each kiln is driven by a 75-hp. Allis-Chalmers motor, an emergency drive being provided by a Novo gasoline engine connected to the kiln drives through a hand-operated clutch. The kilns are mounted on 25-ft. centers.

Pulverized coal is fired in the kilns through Bayley burners consisting of direct-current motor-driven blowers with automatic fuel-feeders. The fuel is prepared for the burners by a pulverizing-and-drying plant located adjacent to the clinker-cooler building fronting the storage area. Coal from storage is delivered to a 20-ft. by 20-ft. hopper, which supplies an inclined belt-conveyor, the head pulley of which is a Dings magnetic separator. The coal then passes through a Jeffrey crusher and



Twin hammer-mill installation. Note direct discharge into storage building.

into an Allis-Chalmers 8-ft. by 55-ft. rotary drier. From this an elevator and a series of screw-conveyors deliver the dried fuel to four feed-bins over the Fuller-Lehigh mills. The latter are 42-in. units, each driven by a 100-hp. motor; screw-conveyors carry the pulverized coal to a duplex set of Fuller-Lehigh pumps which send it to the fuel-storage tanks in the burning building.

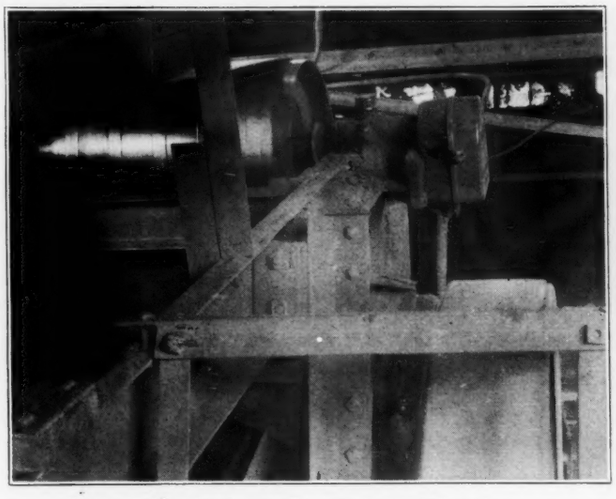
Clinker from the kilns passes directly from their discharge ends into rotary coolers which extend into

The fireless locomotive for tunnel service.

the open-storage building. These units are of Allis-Chalmers manufacture and are 8 ft. in diameter by 70 ft. in length, the first 25 ft. of which is lined with firebrick. Eight-inch I-beam lifters in the 35-ft. rear section assist the cooling through providing greater air contact with clinker pebbles.

Two separate stock-piles of clinker are formed by the traveling crane. One pile, directly in front of the coolers, provides storage for the fresh clinker. A second pile, in front of the finish-grinding department, supplies the finish-grinding mill feed, material from this pile being taken from one end. As the fresh pile grows, the feed pile decreases and a uniform space between the two is therefore maintained. By recovering clinker from the bottom of the feed pile and by means of this system of stock-piling, a uniform product is delivered to the finish-mill feed-hoppers.

The finish-grinding department contains four Allis-Chalmers 2-compartment 7-ft. by 26-ft. Compeb mills, each of which is driven by a 500-hp. Allis-Chalmers synchronous motor through a Cutler-Hammer magnetic clutch. A series of hoppers similar to those of the raw-grinding department furnish the clinker-supply to the finish-mill feeders. A series of 16-in. screw-conveyors transfer the fin-

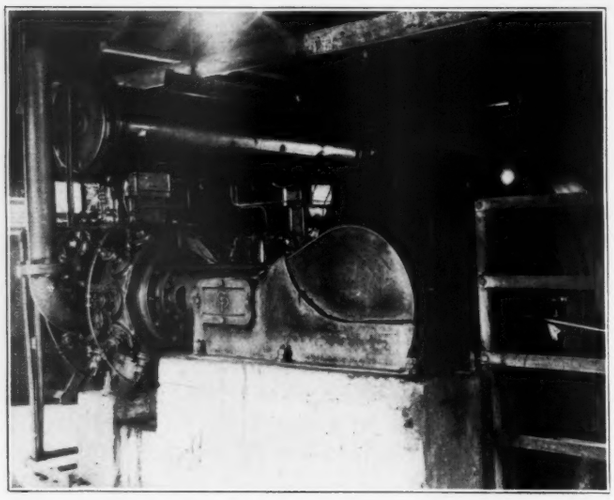


Magnetic-separator pulley on raw-coal conveyor.

Coal-mill machinery. Fuel pump in foreground.

A corner of the laboratory showing air-separation apparatus.

ished cement from the mills to an elevator, which supplies a screw-conveyor over a bridge to the pack-house. Another elevator and series of screw-conveyors transfer the cement to six silos, the original



One of the air-compressors.

units built in 1923. Each screw-conveyor unit in the series is driven by a 15-hp. motor through a Jones speed-reducer. For the new silos a Fuller-Kinyon pump has been installed in the finish-grinding department. This unit is piped to the first six silos also.

Air-separation as applied to the finish grinding of cement is employed at the Signal Mountain plant on the No. 1 mill. A Sturtevant 14-ft. air-separator has been installed in closed-circuit. In view of the success of this process at one of the other plants of the Cowham Engineering Co., the completion of the Signal Mountain installation is anticipated for sometime in the future.

With the addition of six silos, the company has a total of 12 silos with three pack-houses. Each silo has a net capacity of 13,700 bbl. Two 16-in. reversible screw-conveyors underneath each group of silos provide a flow of cement from any silo to a pack-house on either end of the group. The system includes also a Fuller-Kenyon pump which is used to transfer cement from one silo to another. In each of the pack-houses two Bates 3-tube packers are installed for sacking the cement. The sacks are cleaned and repaired in a building adjacent to the center pack-house, which is equipped with a Modern Valve Bag Co. sack cleaner.

For laboratory control over raw materials and the finished product the company maintains a com-

Dump cars unloading stone to the primary crusher.

plete chemical and physical laboratory in the plant office-building. A Southwark-Emery hydraulic compression and tensile testing-machine and a Federal laboratory air-separator feature the wide range of equipment.

Electric power is purchased from hydro-electric power-plant developments in the vicinity. Through a substation at the mill, the 11,000-v. power is stepped down to 2,300 v. for the grinding-department motors and to 440 v. for small auxiliary motors. Direct current for the pulverized-fuel burner blowers and other variable-speed equipment is furnished by two motor-generator sets located in the finish-grinding building.

Water is supplied to the mill and quarry from a gravity tank located on the hillside above the plant. An Allis-Chalmers 5-in. by 4-in. pump, driven by a 30-hp. motor, draws water from a near stream and delivers it under float control to the gravity tank.

WHEN the seasonal demand for lime drops off, the Dixie Lime Products Co. of Kendrick, Fla., turns its attention to producing rock for road work, thus stabilizing operations. A story describing this plant begins on page 44 in this issue.

Geology and Industrial Development of Illinois' Nonmetallic Minerals*

By J. E. LAMAR
Geologist, Illinois Geological Survey

ILLINOIS produces a large variety of nonmetallic minerals and mineral products, among which limestone, cement, lime, silica sand, and sand and gravel occupy a very important place, both from the standpoint of volume of material produced and its economic value. Inasmuch as limestone, sand and gravel and their products are in part, at least, related directly or indirectly to the construction industry, the mines and quarries from which these products come are to be found concentrated, insofar as distribution of raw materials allows, around the populous centers of the state. Fortunately the geologic conditions of Illinois are such as to allow the development of unusually large nonmetallic industries in the Chicago, Ottawa - LaSalle, and southwestern Illinois districts, and to offer opportunity for future development elsewhere.

The development of the limestone, cement, lime, silica-sand, and sand-and-gravel industries in Illinois has been rapid. Starting with a production valued at more than $10,000,000 in 1909, the value increased to $16,500,000 in 1919 and to almost $30,000,000 in 1929. The value and quantity of material taken from the ground during the period for which production records have been kept is extremely large. For example, between the years 1890 and 1929 the crushed-stone industry alone produced stone valued at almost $160,000,000 which, at an average price of $1 per ton, would have required a pit 1 mi. square and more than 70 ft. deep, had it all been taken from one quarry. The gravel and sand produced since 1904 would have required a pit still larger, 1 mi. square and 155 ft. deep. If this quantity of gravel were spread out in a road 15 ft. wide and 1 ft. deep it would make more than 54,000 mi. of such road, or a pavement long enough to circle the earth twice.

In Table I the general distribution of the outcropping rock formations of Illinois and their related mineral products are presented in tabular form. Aside from the products listed, it is of interest that the Pennsylvania or Coal Measures rocks, as they are sometimes called, are the source of all Illinois' coal and much of its clay.

Fig. 1. Location of limestone districts, character of the bedrock and distribution of limestone plants in Illinois.

Limestone and Dolomite

General Statement.—The limestones and dolomites of Illinois are utilized in three main industries, namely (1) crushed-stone, (2) cement, and (3) lime. Crushed stone includes concrete aggregate, railroad ballast, flux, agricultural limestone, and the like. Throughout this discussion a distinction is made between limestone, which is a stone composed essentially of calcium carbonate, and dolomite, which is a double carbonate of calcium and magnesium, as their distribution is for the most part quite distinct throughout the state.

Distribution and Character.—The distribution of the limestone formations of Illinois is shown in a general way in Fig. 1, wherein the state is divided into five major districts. District 1 in northern Illinois is underlain almost exclusively by dolomites or magnesian limestones with the exception of the high calcium Wapsipinicon limestone near Moline in Rock Island County. The rocks ex-

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posed in this area are among the oldest in Illinois and represent five principal formations, the Shakopee, Platteville, Galena, Kankakee, and Niagaran dolomites (Table I). Their general physical and chemical character is shown in Table II.

In District 2 limestones of Lower Mississippian age predominate. These rocks vary from clayey limestones to very pure high-calcium rock. Prob-

Fig. 2. National Stone Co., Joliet, Ill. The two levels being quarried are shown.

ably the outstanding formation in this area is the Burlington limestone which is a coarsely crystalline, very pure rock but contains a considerable amount of bedded chert (Table II). Other important formations are the Spergen and Niagaran (Table II).

District 3 is underlain in part by Lower Mississippian and in part by Upper Mississippian strata. The former are for the most part high-calcium limestone (Table II) and the latter are of highly variable character and are interbedded with shale or sandstone formations. Some thick limestone formations, such as the Okaw formation (Table II) are quarried locally.

District 4 is underlain by Lower and Upper Mississippian rocks which are in general similar to those in District 3.

District 5 is underlain by the Coal Measures rocks which are principally shale, sandstone, and coal. Locally, however, beds of limestone are present which are sufficiently thick to be worked commercially (Table II).

Nature of Deposits.—District 1 is a region of flat or gently rolling country. The rocks are for the most part flat-lying and well bedded (Fig. 2). Quarries in this area are almost all pit quarries with the exception of a few small bluff quarries along the Mississippi River in the western part of the district.

Districts 2 and 3 include the Mississippi and Illinois river-bluff areas. The strata are mostly flat-lying and quarries located in bluffs or hills are most common (Fig. 3). Combinations of pit and bluff quarries have been developed locally. In Jersey, Madison, Monroe, and Adams Counties mining has been resorted to in places.

District 4 is broken, hilly country and the quarries in it are mostly developed in hills. Their rocks are generally flat-lying.

The quarries in district 5 are mostly pit quarries.

Crushed Stone

Distribution of Industry.—The crushed-stone industry of Illinois is centered in the Chicago area, including Cook, Dupage, Will, and Kankakee Counties, in the Quincy area of Adams County, the East St. Louis area of St. Clair and Monroe Counties, and the extreme southern Illinois area in Union,

Table I.—RELATION OF GEOLOGY TO NONMETALLIC MINERALS AND MINERAL RESOURCES

Geologic Period	Area of Outcrop of Strata in Illinois	Minerals Produced from Strata of This Period	Name of Principal Producing Formation	Potential Undeveloped Resources
Recent	Stream valleys; peat in ancient lakes	Gravel, sand, peat		
Pleistocene	Entire state, except 7 counties at southern tip; gravel phases especially well developed in northern part of state	Clay, molding sand, sand and gravel		
Pliocene	Alexander, Pulaski, Massac, and Union Counties	Gravel and sand	Lafayette	Possibly molding sand
Eocene	Pulaski, Alexander, and Union Counties	Fullers' earth	Porter's Creek	
		Clay	Lagrange	Molding sand
Cretaceous	Pulaski, Massac, and Pope Counties	Clay	Ripley	Molding sand
Pennsylvanian	Central portion of state, north-south from La Salle to Jackson Counties inclusive, east-west from central Adams County to state line. (See Dist. 5, Fig. 1.)	Cement	La Salle	Building stone (sandstone) Possibly rock wool
		Clay	Cheltenham and others	
		Limestone	Pontiac and others	
		Abrasives	Pottsville	
Mississippian	A belt 6 to 30 mi. wide along Mississippi River from Mercer County south to Jackson County; and in Union, Johnson, Pope, and Hardin Counties. (See Dists. 2, 3 and 4, Fig. 1)	Limestone	St. Louis, Ste. Genevieve, Spergen, Burlington, Okaw	Cement, clay, possibly rock wool
		Limestone (lime)	Burlington	
		Fluorspar	Ste. Genevieve, St. Louis	
Devonian	Rock Island, Calhoun, Union, and Alexander Counties	Limestone	Wapsipinicon	
		Silica, novaculite, gravel, gannister, clay	Clear Creek chert	
Silurian	Northwest and northeast Illinois (see east and west portions of Dist. 1, Fig. 1)	Dolomite (dolomitic lime)	Niagaran dolomite	
Ordovician	Central northern Illinois; Calhoun and Alexander Counties	Limestone	Kimmswick limestone	High-calcium lime, possibly rock wool
		Cement, limestone	Platteville limestone	
		Silica sand	St. Peter sandstone	
		Natural cement	Shakopee dolomite	

Table II.—GENERAL CHARACTER OF ILLINOIS LIMESTONES AND DOLOMITES

System	Formation	Source of Samples	General Chemical Character	General Physical Character as Shown by the French Coëfficient[1]
Pennsylvanian (Coal Measures)	Shoal Creek	Litchfield, Montgomery County West Union, Clark County Fairmount, Vermilion County	High-calcium limestone High-calcium limestone High-calcium limestone	High-medium Medium Medium
	La Salle	La Salle, La Salle County	Argillaceous limestone	
Mississippian	Okaw	Randolph County	Usually over 92 per cent. calcium carbonate	High-medium
	Ste. Genevieve	Madison, Union, Johnson and Hardin Counties	High-calcium limestone	High-medium
	St. Louis	St. Clair and Madison Counties	High-calcium limestone	High-medium
	Salem (Spergen)	Monroe County Brown County	High-calcium limestone Somewhat siliceous limestone	High-medium
	Burlington	Quincy, Adams County	High-calcium limestone	Low-medium
Devonian	Wapsipinicon	Moline, Rock Island County	High-calcium limestone	Medium
Silurian	Niagaran	Cook County Will County Kankakee County	Dolomite, high in carbonates Dolomite, high in carbonates Dolomite, high in carbonates	Medium Medium Medium
Ordovician	Kimmswick	Monroe County	High-calcium limestone	Low-medium
	Galena	Lee, Ogle, Winnebago, Boone, Stephenson Counties	Dolomite, high in carbonates	Medium
	Platteville	Dixon, Lee County	Limestone, locally dolomitic	Medium
	Shakopee	Utica, La Salle County	Argillaceous dolomite	Low

[1]For classification of French coëfficients, see Ill. Geol. Survey, Bull. 46, page 39.

Johnson, and Hardin Counties. The value of the crushed stone produced in the Chicago district was 68 per cent. of the total state production of almost $7,000,000 in 1929.

Methods of Quarrying.—In most quarries churn drills are used for drilling primary-blast holes and jack-hammers for secondary drilling. Dynamite is the explosive commonly used for blasting. Steam-shovel loading is commonly employed and transportation to the primary breaker is by steam, gasoline, or electric locomotives. The usual flow-plan is generally followed in the crushing plants—the rock is first crushed in the primary breaker and subsequently further broken in reduction crushers. Some plants that supply a considerable amount of agricultural limestone have special pulverizing equipment.

Resources.—Illinois is amply supplied with undeveloped resources of limestone. Northern Illinois offers many attractive quarry sites, some of them within the Chicago district. Especially attractive sites are to be found in the dolomite area in the western half of District 1, in the southern portion of District 2 where a variety of high-calcium limestone is available, in the Mississippi bluffs of Monroe County (District 3) where tremendous quantities of stone are available, and also in District 4.

In the Pennsylvanian (Coal Measures) area (District 5) there are numerous sites capable of furnishing limestone to supply local demands. One area in Livingston County and certain parts of Clark County appear to offer opportunities for relatively large-scale development.

Fig. 3. Columbia Quarry Co., Krause, Ill. Note thickness of the overburden.

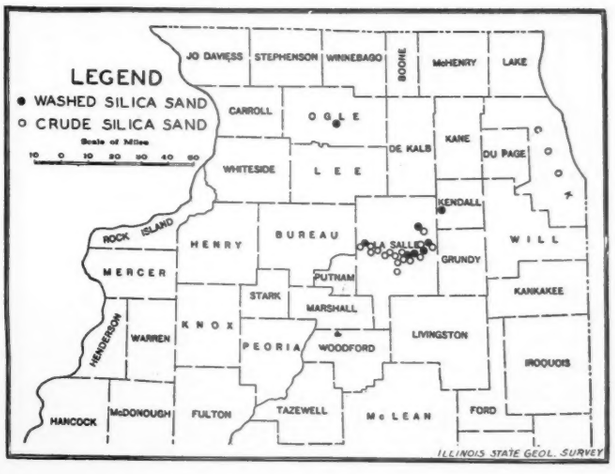


Fig. 4. Distribution of silica-sand quarries.

Production Data.—In 1929 Illinois produced more than 8,300,000 tons of crushed stone which sold for approximately $7,000,000. The chief uses of this stone were as follows:

	Tons	Value
Concrete and road metal	5,327,310	$4,221,762
Railroad ballast	963,240	724,302
Agricultural	947,800	843,693
Fluxing stone	786,020	749,721
Riprap	135,080	132,971

Fig. 5. Medium-sized St. Peter sand magnified about 35 times.

Illinois produces two types of cement, Portland and natural. Both industries are centered in the northern part of the state, principally in La Salle County.

Portland Cement.—Four plants produce Portland cement in Illinois, three at La Salle, La Salle County, and one at Dixon, Lee County (Fig. 1). The plants at La Salle derive their raw material from the La Salle limestone, a Pennsylvanian (Coal Measures) formation, gray to buff in color, usually brecciated, in relatively thick layers, and of such composition that the addition of a small amount of shale makes a satisfactory raw mix.

The thickness of the La Salle formation varies from 20 to 30 ft. It occurs at the surface in the vicinity of La Salle as the result of an upfold of the bedrock. So far as is known, it outcrops only in the vicinity of La Salle over a relatively limited area.

Both open-pit quarrying and mining are employed at La Salle. Inasmuch as the bed is not very thick and production from this region has been large, the quarries are of great lateral extent.

Steam-shovels are used for loading. Electric and steam locomotives are used for transporting the stone to the mill, where it is crushed, mixed with the necessary clay, and fed into the kiln. All the cement manufactured is made by the dry process.

The mill at Dixon derives its raw material from a large quarry in a nondolomitic phase of the Platteville formation. Shale or clay derived locally or brought from the coal-mine dumps in the vicinity of La Salle is added to complete the raw mix. Loading, transportation, and manufacture are for the most part similar to those operations at La Salle.

In 1929, Illinois produced 8,242,725 barrels of Portland cement valued at $8,940,166. In addition to this the cement manufacturers also marketed a considerable quantity of special cements.

Natural Cement.—Natural cement is made at only one point in Illinois, namely at Utica in La Salle County (Fig. 1), where certain portions of the Shakopee dolomite are being quarried. The Utica district has long been one of the country's most important natural-cement producing centers and was particularly active in the years preceding the discovery of Portland cement. The older developments involved mining in the north bluff of the Illinois River, but the present company is quarrying stone from the floodplain of the Illinois River just south of Utica and has recently extended its workings below ground in those areas where the overburden to be stripped was thick.

Although the bluff in the vicinity of Utica is locally honeycombed with mines, there is probably a considerable amount of stone available in this area by subsurface mining. Testing and exploration may also reveal areas where rock may be stripped. The Shakopee Formation also outcrops in Lee and Ogle Counties of northern Illinois and may be suitable for making natural cement in some parts of these counties.

Lime

The lime-producing districts of Illinois are located in Cook, Adams, and Rock Island Counties (Fig. 1). In Cook County a dolomitic lime is burned from the Niagaran dolomite, and a considerable quantity of imported high-calcium limestone

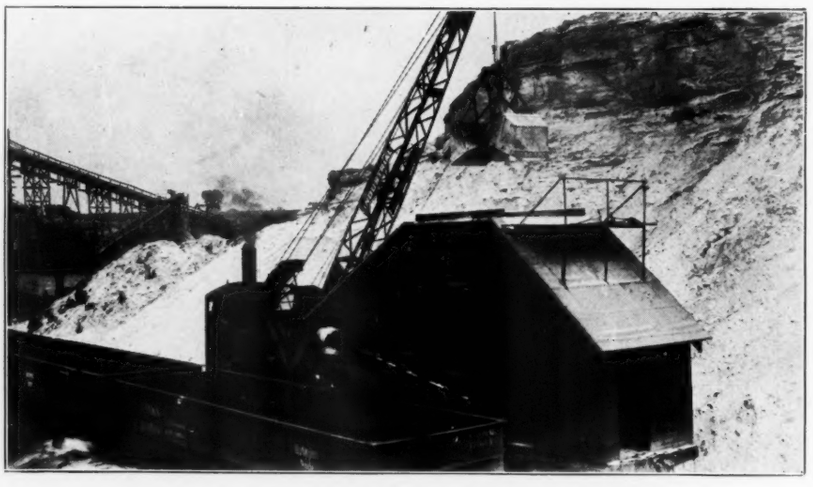


Fig. 6. Operations of the Buffalo Rock Silica Co.

is also burned for making high-calcium lime. In Adams County a non-cherty phase of the Burlington Formation supplies the raw material for the manufacture of a high-calcium lime and in Rock Island County the Niagaran dolomite is being burned to make dolomitic lime.

In the Chicago and the Rock Island County districts the stone is quarried by open-pit methods. In Rock Island the stone is won by subsurface mining, because the bed being worked is less than 30 ft. thick and the overburden is heavy.

Illinois is well supplied with raw materials for making dolomitic lime. In District 1 practically every county except McHenry and Lake has deposits of dolomite which could probably be used to make lime. In District 2 the Burlington Formation outcrops extensively and, where locally free from chert, can be used as a source of material for making lime. In southern Calhoun, Greene, Jersey, and Madison Counties other limestones suitable for making high-calcium lime are available in relatively thick deposits which are free from chert. Such a deposit was at one time worked at Alton as a source of stone for making high-calcium lime. Rock for making dolomitic lime is available only in Calhoun County. Districts 3 and 4 offer many favorable sites for lime quarries and plants; all rock available is of the nondolomitic type. District 5, because of the thin limestones, offers only a few attractive sites for lime plants; the rock in Clark and possibly also that in Livingstone County appears to be the most valuable.

In 1929 Illinois produced 119,382 tons of lime valued at $973,312. Of this total, 33,659 tons was hydrated and sold for $274,001.

Silica Sand

Distribution.—The silica sand produced in Illinois is derived exclusively from the St. Peter Formation, in the vicinity of Ottawa in La Salle County, where the formation is exposed in the bluffs and valley-floor of the Illinois and Fox Rivers (Fig. 4). Other outcrops occur along the Fox River in Kendall County and in Ogle and Calhoun Counties.

The St. Peter sandstone in general is composed of unfractured quartz grains, the larger of which are rounded and frosted (Fig. 5). The extremely fine grains, however, are only partly frosted or are angular. A few other mineral grains such as zircon and tourmaline are present but in extremely small proportions.

The sand found in the bluffs along the Illinois River in La Salle County is for the most part yellow or light yellow in color. Locally it contains masses of pyrite and in places is stained brown. Both the yellow and brown colors are due to hydrated oxides of iron. The clay content varies somewhat but in general is comparatively small, usually less than 4 per cent.

The deposits in the valley-floor of the Illinois River and its associated terraces are for the most part white or light cream in color. The sandstone contains pyrite in small quantities and is locally stained yellow by iron oxides, but much less so than the deposits in the bluffs. The clay content in the white and cream sand is variable but in general is slightly less than that of the sand in the bluffs.

Production Methods.—The yellow sand in the river bluffs is usually mined by open-pit methods. The overburden of pebbly clay and, locally, shale, clay and coal varies from a few feet to 25 ft. in thickness and is usually removed mechanically. The sand is blasted down and loaded mechanically either by steam-shovels, cranes, or drag-line scrapers in cars or on belts which convey it to crushers,

Fig. 7. Hydraulic quarrying of the St. Peter sand.

where it is reduced to pass a ¼-in. sieve or finer (Fig. 6). This type of sand is generally called crude silica sand and is sold principally for steel molding, fire, and furnace sand.

The sand in the quarries of the valley-floor of the Illinois River has a comparatively thin overburden from 2 to about 10 ft. This is stripped and the surface of the sandstone thoroughly cleaned by sweeping and compressed-air or steam jets. Blast holes are made with churn drills, the stone is shot down and usually allowed to weather for a time in order to produce additional disintegration.

Hydraulic quarrying is employed in open pits. The sand is washed by water to a sump (Fig. 7) from which it is pumped to a drag-belt elevator. From this it is conveyed to a scalping screen where lumps of sand and pyrite are removed, then goes to the washers, driers, and screens (Fig. 8). Sand is generally washed twice in rectangular washers and once during the transfer and deposition in the

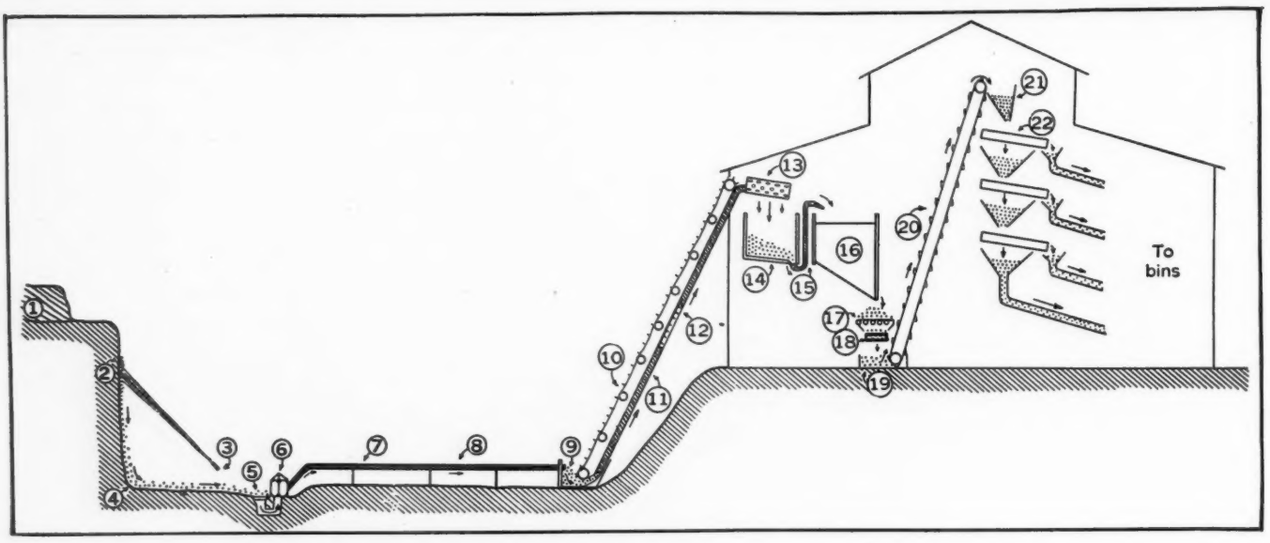


Fig. 8. Generalized diagrammatic flow-sheet for washed St. Peter sand showing the progress of the sand from the quarry face to the storage bins. ***(Illinois State Geol. Survey Bull. 53, Fig. 22.)***

(1) Overburden to be removed.
(2) Quarry face—loose sand.
(3) Stream of water under 40-100 lb. pressure.
(4) Sand and water run down quarry face to sump.
(5) Iron grate for screening out lumps of sandstone.
(6) Sand pump, steam or air-operated.
(7) Iron pipe conveying sand to elevator.
(8) Sand from different faces of the quarry.
(9) Pipe-line discharge.
(10) Drag-belt elevator or conveyor.
(11) Trough on which cleats on belt drag up the sand.
(12) Side of trough removed showing operation of cleats.
(13) Cylindrical scalping screen. Material not passing is discarded.
(14) Washers. Strong jet of water directed on sand frees it from clay. Clay flows off and is discarded.
(15) Sand is pumped from washer to draining bins.
(16) Draining bins. Sand feeds by gravity to drier.
(17) Steam-coil drier. When dry, the sand falls between coils to conveyor belt.
(18) Conveyor belt takes dried sand to bin.
(19) Bin. Sand feeds from bin to bucket-belt elevator.
(20) Bucket-belt elevator carries sand to top of screen house.
(21) Bin which distributes sand to sieves.
(22) Sieves. Sand retained goes through wooden spout to storage bins. Sand passing sieves falls into collector and is spouted to another sieve.

draining bins. It is dried commonly on steam-coil driers and subsequently screened on vibrating screens. Washed silica sand has many uses, among which are glass sand, cutting, grinding, and blast sand, molding sand, sand for making sodium silicate, and for silica.

Resources.—In general it is thought that in the Ottawa district most of the deposits of silica molding sand most favorably located with reference to rail transportation and most naturally available are now being developed. The north bluff of the Illinois River in the vicinity of Ottawa is largely taken up by molding-sand quarries, although additional sites may be available in some places. The overburden becomes heavy back from the face of the bluffs, in most places so that extension of the quarries into the bluffs appears unlikely at present except in certain places. The south side of the river is without railroad transportation but those deposits not included in Starved Rock State Park will be made available with the opening of the Illinois Waterway. Other molding-sand deposits having railroad transportation are available in northwestern La Salle County, possibly in the northeastern part of the county, and in Ogle County. The deposit in Calhoun County, which will also provide molding-sand, is located on the Mississippi River.

Additional deposits of white St. Peter sand, suitable for glass and the like, may be available from the south side of the Illinois River when the Illinois Waterway offers transportation. Sites with railroad transportation are now largely under development. Ogle and Calhoun Counties may offer additional sites for glass-sand quarries but the Ogle County sand is frequently too iron-stained to be usable. The Calhoun County deposit contains some lime and iron and is slightly finer than the La Salle County sand but otherwise may probably be used as a source of glass sand if the impurities can be removed by washing.

Production Data.—The production of St. Peter sand in 1921 amounted to more than 2,000,000 tons which sold for almost $3,000,000. Molding, glass, and blast sand accounted for 73 per cent. of the total production and 61 per cent. of the total value. Silica, which is produced by finely pulverizing St. Peter sand, accounted for 4 per cent. of the quantity and 19 per cent. of the value of the production.

Sand and Gravel

Glacial Gravel.—Practically all the sand-and-gravel deposits of Illinois are directly or indirectly related to the great continental glaciers which covered large portions of the state during Pleistocent times, especially the Wisconsin glacier which covered a large portion of the northeastern part of the state. These glaciers formed in northern Canada and extended southward into Illinois, carrying with them rock materials obtained from those areas over which they passed. These materials consisted of a mixture of clay, sand, pebbles, and boulders and in themselves are not good sources of gravel. However, when acted upon by water the clay is removed, leaving the sand and coarser particles. The glacial-gravel deposits of Illinois were laid down by

Fig. 9. Distribution of sand and gravel plants.

streams which flowed upon, within, or beneath the glacier or which emanated from the glacier. The ancient Illinois, Fox and Rock River valleys carried tremendous streams of water from the melting glaciers and consequently huge fillings of sand and gravel were built up in these valleys. It is interesting to note that the distribution of the sand-and-gravel industry of Illinois (Fig. 9) is closely related to the present courses of these streams. Other sand-and-gravel deposits are associated with the materials washed into the Wabash and Mississippi Rivers and still others are found in deposits that were formed at the immediate ice front or even within the glacier.

The glacial gravel is composed of all types of rock material, including many varieties of igneous rocks such as granite, trap rock, and the like, as well as fragments of limestone, sandstone, and shale. The outstanding rock constituents in Illinois in general are limestone and dolomite.

Nonglacial Gravels.—The nonglacial gravels of Illinois are found in the three southernmost counties of the state and are known as the Novaculite, Elco, and Lafayette gravels. The first occurs in Alexander County and consists of chert fragments with a binder of red clay (Fig. 10). It has been derived by the fracturing and weathering of one of the bedrock formations, the Clear Creek Formation, which is itself composed almost exclusively of chert or its weathered products.

The Elco gravel is found along Mill Creek in the same county and is a stream-deposited, rounded-to-angular chert gravel containing clay and some quartz sand.

The most widespread gravel of extreme southern Illinois is the Lafayette gravel. It consists of rounded, bronze-colored chert and is found on the uplands of southwestern Union, Alexander, Pulaski, and Massac Counties. Its thickness varies from a few feet to about 50 ft. and in the vicinity of Metropolis, where it appears to have been reworked by streams, it is sufficiently thick to be of commercial importance.

Production Methods.—Methods of producing gravel vary from the simple small-scale hand-loading operations to the complex processes used in large-scale developments (Fig. 11). Loading in large-scale developments is usually by mechanical shovel, crane, dredge, or scraper. Transportation from pit to plant is by conveyor belt, cars, or, lo-

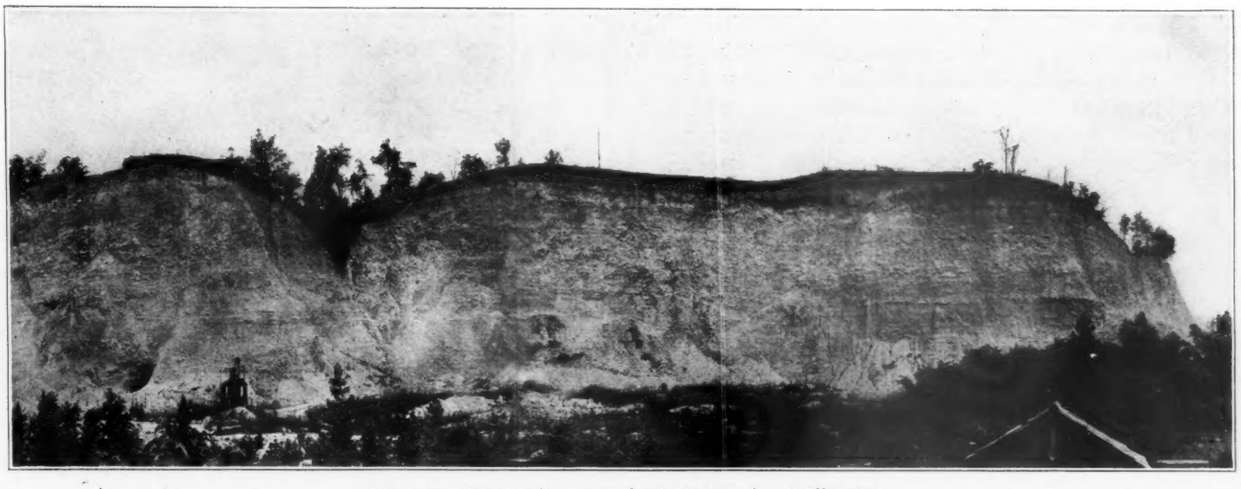


Fig. 10. Novaculite gravel pit in southern Illinois.

cally, through pipes if the gravel is being dredged, or by combinations of the foregoing. About 85 per cent. of the sand and gravel produced in Illinois is washed and a considerable quantity is crushed. Sizing is usually accomplished by rotary screens; some vibrating screens are used for separating sand and fine grades of gravel.

Resources.—The sand-and-gravel resources of Illinois have been barely touched. The Illinois River valley contains inexhaustible supplies of sand which extend north from northern Calhoun County almost continuously to the "Big Bend" at Hennepin. Tremendous quantities of gravel and sand are found along this valley, especially between Pekin and Lamont, and other immense reserves are found along the Fox and Rock River valleys. Southern Illinois in general is without large deposits of glacial sand

Fig. 11. Plant of the Chicago Gravel Co. at Plainfield, Ill.

and gravel but large quantities of gravel are available along the Ohio and Wabash Rivers and considerable quantities of sand along the Mississippi. Extreme southern Illinois has a wealth of gravel from the Novaculite, Elco, and Lafayette deposits.

Natural-Bonded Molding Sand.—The natural-bonded molding sand (Fig. 9) of Illinois is usually directly or indirectly related to the glacial deposits discussed above. Molding sand of this origin is commonly a concentration of the finer materials from the glacial till to which there has, in many places, been added naturally a small amount of organic material in the form of humus. Along the Mississippi River, however, much of the molding sand is material which has been blown up from the floodplain of the river and dropped on the bluffs.

Production Data.—The production of sand and gravel in Illinois in 1929, excluding silica sand, totaled more than 16,000,000 tons which sold for almost $7,000,000. The total production of sand constituted 45 per cent. by weight and 41 per cent. by value of the sand-and-gravel production of the state. The sand was used chiefly for structural, paving, and railroad-ballast purposes, which uses employed respectively 24, 12, and 5 per cent. of the total production of sand and gravel.

The gravel produced comprised 55 per cent. by weight and 59 per cent. by value of the state's output, and was used chiefly for concrete and structural purposes, paving and road-making, and railroad ballast, which uses consumed respectively 21, 21, and 11 per cent. by weight of the total production.

The production of natural-bonded molding sand amounted to almost 270,000 tons and sold for $175,000.

The foregoing data on limestone and silica sand are discussed more fully in Bull. 46 of the Illinois Geological Survey on the "Limestone Resources of Illinois," by Frank Krey and J. E. Lamar, and Bull. 53 on the "Geology and Economic Resources of the St. Peter Sandstone of Illinois," by J. E. Lamar, which may be obtained by addressing Dr. M. M. Leighton, chief of the survey, at Urbana, Ill.

Production of Asbestos and Mica in Union of South Africa

During the first quarter of the current year the Union of South Africa produced 406 long tons of asbestos and Southern Rhodesia 11,145 tons; corresponding figures for the first quarter of 1930 are 1,143 and 11,988 tons, respectively. There was no production in Northern Rhodesia. Exports of raw asbestos from the Union of South Africa during the first three months of 1931 came to 9,297,946 pounds, of which 4,573,917 went to the United Kingdom and 1,154,886 to Italy, the remainder being divided among a large number of destinations, including the United States. As all but a very small proportion of the asbestos output of the Union is exported, the prevailing industrial depression has adversely affected production of all three varieties—amosite, chrysotile, and blue asbestos. Among the larger producers output has been considerably reduced, and a number of the smaller producers have ceased operations temporarily. The Union of South Africa increased its mica production from 65 tons in the first quarter of 1930 to 280 in the corresponding months of 1931, but the output of Southern Rhodesia dropped from 55 tons to 16 tons in the same interval, while Northern Rhodesia, with a trifling output in the former period, had none in the latter. The Union exported 337 tons during the first quarter of the present year, 280 tons going to the United States and the remainder to Mozambique.

THE vision of designing engineers in planning a cement mill to provide for future expansion with little interference to production is exemplified in the Chattanooga plant of the Signal Mountain Portland Cement Co. This operation is described and illustrated in a seven-page story beginning on page 16 in this issue.

Pennsylvania's Stone Producers Discuss Plans for National Convention

Monthly Meet Takes Form of Outing as Members Frolic at Ye Olde Dutch Barn

By HARRY E. HOPKINS

TO realize how impressive was the August meeting of the Pennsylvania Stone Producers' Assn. one need only to know that two of the national association's officials present apologized for their absence from these monthly meetings, with a firm purpose of amendment in the future.

The meeting was called for the morning of Aug. 27, at the plant of the Bethlehem Mines Corp., a subsidiary of the Bethlehem Steel Co., at Bethlehem. Producers from all parts of the Keystone State attended, several of them motoring more than 200 mi. from their home plants. Neither accident nor illness could deter them. As an instance, Paul Reinhold, on his way from Pittsburgh, collided with a lady horse in the environs of Harrisburg, and narrowly escaped serious injury. The horse was killed and his car badly damaged.

During the morning the visiting producers were guided over the crushing plant and the quarry under the able leadership of M. L. Jacobs, general manager of the Bethlehem, and his assistants. The inspection was intensely interesting throughout—the size of the plant, its equipment, the unusual rock formation which the company utilizes in making stone sand. One wondered at first how such material was of much value until its production was described by Mr. Jacobs, who is an authority on this subject. His exhaustive studies were published in the *Crushed Stone Journal* of the national association.

Luncheon was announced at the conclusion of the inspection. Members and guests were taken in automobiles to the Bethlehem company's century-old Dutch barn, some 10 minutes' ride from the plant. And what a delightful spot to enjoy an informal luncheon! Nestling under the shadow of the Lehigh mountains, three stories in height, surrounded by apple orchards, corn and hay fields, its red roof and white walls reflecting the sunshine, the air redolent of crops—here is the ideal spot for exchange of friendliness and for calm deliberation! Those who visited the Barn for the first time were "sure we'll come again."

Under the supervision of A. N. Roberts, the Bethlehem Steel's real-estate manager, and his three assistants, the luncheon was set out in the main room, under the hand-hewn rafters and near an open fireplace that would have satisfied an antique connoisseur.

The guest drew up to the table and informally helped himself. A bright spot on the menu was "the cup that cheers but not inebriates"—Bethlehem's interpretation of a Coca-Cola, creamy and inspiring. It was done full justice.

The formal meeting came to order, literally, "under the shade of the old apple tree." Each man grasped his end of a bench or chair and carried it down the sloping driveway to the orchard, or threw himself full length on the grass. President Fred Earnshaw and Secretary Paul Reinhold dignified their office by sitting on a bench.

Mr. Earnshaw presided. An early matter for disposal was the Pennsylvania association's part as local host of the National Crushed Stone Assn. convention to be held at Pittsburgh in January.

It was the unanimous opinion that while due regard must be had for present trade conditions, necessary economy, and the like, it behooved the Pennsylvania association to demonstrate that it was no niggard in spending money; that ample funds would be forthcoming to provide adequate entertainment with a first-class program.

Right here it should be recorded that the national association visitors were President A. L. Worthen, Executive Secretary J. R. Boyd and A. T. Goldbeck, director of the Bureau of Engineering, who, as we have intimated, were delighted with their visit and will repeat it many times.

Secretary Boyd, who is arranging the entertainment program for Pittsburgh, stated that he knew the Pennsylvania producers were with him to a man to make the coming convention "the best ever," and that ample funds would be placed at his disposal. He said: "While there had been considerable criticism by chambers of commerce and the industrial bodies that too much money is being expended on entertainment by conventions and other semi-public meetings in this period of depression, it was the national officers' opinion that such entertainment nowise detracted from the main purpose of the convention. Entertainment was but healthy relaxation from the work of the daily sessions." Pennsylvania is dead sure of it!

Some changes in the association's budget for the year were made to accord with present conditions and to be helpful in other contemplated plans.

The Entertainment Committee appointed consists of Otho M. Graves, chairman, William L. Andrews, Edward Lewis, E. T. Wolfe, and F. W. Cramer.

Three new members were welcomed into the fold: R. K. Kibblehouse, Whiterock Quarries, Bellefonte; C. W. Kinsella, Howellsville Quarries Co., and H. I. Sugarman, A. Sugarman & Sons, Devault. In their brief talks each new member pledged their utmost to carry on the work of the state association.

The Credit Plan of the General Contractors was under discussion, but Secretary Reinhold stated that, before taking further action, a member of the

bureau would appear at an early meeting and discuss its phases.

National President Worthen spoke eloquently of his visit, making a strong plea for the support of the Pennsylvania association for the coming national convention. You may rest assured he got it! After reviewing the present business situation, he told of the great value of the national association to the individual producer. Mr. Worthen asked that Pennsylvania producers do their utmost in further supporting the Bureau of Engineering. Something like $5,000 more is needed to complete the $10,000 necessary to carry on the work in view. He also paid a glowing tribute to the bureau for what it has already accomplished.

Mr. Goldbeck briefly summed up the work of the bureau and its great benefit to all crushed-stone producers, with the limited staff it now has. The bureau should be increased to meet the conditions confronting the industry. Of major importance at this time are the three problems: Stone sand, railroad ballast, and low-cost records.

"It behooves us to give grave consideration to these problems," stated Mr. Goldbeck. "Larger facilities are necessary if the bureau is to handle such matters properly and rightly serve the crushed-stone producer."

Secretary Boyd briefly reviewed the work of the Washington office. "Producers should avail themselves of its excellent facilities. It is doing work that even state associations, let alone the individual producer, can not do. Our office can approach the various governmental departments in Washington. It is equipped to take up all such matters as rates, costs, traffic, questions of engineering that affect the producer. It has spent two years to complete a uniform cost-accounting system. It is for your exceeding benefit; use it!"

Mr. Boyd was eloquent in his condemnation of the practice of price-cutting. In his earnest denunciation he quoted James A. Farrel, president of the United States Steel Corp., who in a national publication declared that "price-cutting was the ruin of good business. It was highly dishonest!"

Mr. Boyd asked that the Washington office be given more hearty support. "Criticize it. Tell us what you do not like about it. We cannot properly serve you otherwise. Our journal reaches the state and county highway engineers and superintendents; they become cognizant of what we as an industry are doing for them; they know that we have a practical knowledge of their engineering problems.

"Join the national as well as your state association. The benefits you will get out of the national body will far exceed the slight expense. . . . Secure the bound volume of the last Proceedings. It is an education in itself. It contains invaluable, practical information needed in your business. . . . Give the convention at Pittsburgh your closest coöperation. Go to Pittsburgh. Meet your fellow producers. Exchange experiences with others. Share your knowledge with others. Your strength is ours; ours is yours."

The formal meeting was concluded by a discussion of highway construction in Pennsylvania and what work is expected in the future.

All in all, this August meeting was a huge success, made practical and interesting by the lively but friendly discussions, with no acrimony or lack of confidence in its purpose.

The Pennsylvania association may well be proud of itself and equally proud of its efficient officers, not forgetting its enviable place of meeting and the fine courtesies extended the members by the Bethlehem Mines Corp.

The attendance was as follows:

H. B. Allen, General Crushed Stone Co., Easton, Pa.
W. H. Andrews, Lake Erie Limestone Co., Youngstown, O.
J. R. Boyd, National Crushed Stone Assn., Washington, D. C.
J. C. Brennan, Howellville Quarries, Inc., Berwyn, Pa.
D. A. Barkley, Bethlehem Steel Co., Bethlehem, Pa.
G. Classe, Howellville Quarries, Inc., Berwyn, Pa.
F. W. Cramer, York Valley Lime & Stone Co., York, Pa.
N. Cascitti, Howe Traprock Co.
J. R. Chamberlin, Mann Co., Inc., Norristown, Pa.
F. A. Earnshaw, Carbon Limestone Co., Youngstown, O.
A. Fauble, Whiterock Quarries, Inc., Bellefonte, Pa.
W. H. Fehr, Berlos Products Co.
John Frimmel, Mann Co., Norristown, Pa.
Otho M. Graves, General Crushed Stone Co., Easton, Pa.
A. T. Goldbeck, National Crushed Stone Assn., Washington, D. C.
F. T. Gucker, John T. Dwyer Co., Norristown, Pa.
Edward Gilbert, Newcastle Lime & Stone Co., Newcastle, Pa.
Sam Given.
W. A. Heyer, Trumbower Co., Inc., Nazareth, Pa.
Harry E. Hopkins, PIT AND QUARRY, New York, N. Y.
M. L. Jacobs, Bethlehem Mines Corp., Bethlehem, Pa.
C. W. Kinsella, Howellville Quarries, Inc., Berwyn, Pa.
F. P. Keim, Trumbower Co., Inc., Nazareth, Pa.
R. K. Kibblehouse, Whiterock Quarries, Inc., Bellefonte, Pa.
Edward Lewis, Bucyrus-Erie Co.
J. Morrison, Earl C. Bacon, Philadelphia, Pa.
H. E. Nauss, Steacy & Wilton Co., Wrightsville, Pa.
J. Gilmore Nelson, Warner Co., Wilmington, Del.
Ray C. Noll, Whiterock Quarries, Inc., Bellefonte, Pa.
L. C. Nesbitt, Burlos Products Co.
W. S. Nice.
J. P. Peacock, Bethlehem Mines Corp., Bethlehem, Pa.
John Rice, Jr., General Crushed Stone Co., Easton, Pa.
H. F. Rothacker, Sanderson-Cyclone Drill Co.
Paul B. Reinhold, P. B. Reinhold & Co., Pittsburgh, Pa.
W. K. Shrayer, H. E. Millard, Annville, Pa.
H. I. Sugarman, A. Sugarman & Sons, Devault, Pa.
W. E. Saxon, Whiterock Quarries, Inc., Bellefonte, Pa.
J. R. Tyson, Bethlehem Steel Co., Bethlehem, Pa.
A. L. Worthen, National Crushed Stone Assn., Washington, D. C.
E. T. Wolfe, E. I. du Pont de Nemours Co., Wilmington, Del.
F. M. Walton, Steacy & Wilton Co., Wrightsville, Pa.

ANOTHER of the series of interesting articles on the nonmetallic mineral resources of the various states appears on page 23 of this issue. It concerns the state of Illinois and appears by permission of the chief of the State Geological Survey.

Studies on the Soundness and Durability of Aggregates and Concrete*

By H. F. GONNERMAN and G. W. WARD
Research Laboratory, Portland Cement Assn.

IT is generally recognized that there are many factors which may affect, either directly or indirectly, the performance of concrete exposed to wide seasonal variations in temperature and moisture. These are the characteristics of the cement, the durability, grading, cleanliness and proportions of the aggregates, the quality of the mixing water and its quantity in relation to the cement, the water-cement ratio, the manipulation of the concrete and the kind and extent of the curing. All these factors are controllable and the extent to which they are controlled will be reflected in the quality of the final product and therefore govern its performance in service.

This paper deals with only one or two phases of this general subject. It presents results of accelerated sodium-sulphate soundness tests and freezing and thawing soundness tests on 58 samples of fine and 47 samples of coarse aggregates, many of which were suspected of containing relatively large amounts of non-durable materials. There are also presented the results of freezing and thawing tests on 2-in. mortar cubes made from 24 fine aggregates of considerable range in quality and other characteristics, and freezing and thawing tests on 6-in. concrete cubes made from 2 different coarse aggregates each in combination with 2 different fine aggregates. The water content of the mortar and concrete mixes was varied over a considerable range to bring out the effect of this important factor.

The most outstanding feature of the tests is the very marked influence of the quality of the protecting cement-water paste on the resistance of the aggregates to freezing and thawing in mortar and concrete. When incorporated in a paste of high quality—rich mix of low water content—even those aggregates which showed relatively poor performance in the soundness tests exhibited a high degree of resistance in 2-in. mortar cubes which withstood as many as 200 cycles of freezing and thawing without showing an excessive amount of failure. On the other hand, when a paste of poor quality was used, mortars made with even the best aggregates showed relatively poor performance under the conditions of these tests. This means that the quality of the cement-water pastes is a most important factor affecting the durability of mortar or concrete. This is a most significant conclusion, not only in the interpretation of these data but also in reference to their application in the improvement of concrete construction, and points the way to the proper use of available materials.

In the case of the fine aggregates, the grading of the particles as well as their other characteristics seemed to have a great influence on the behavior of the mortar cubes when subjected to freezing and thawing. To make a mortar of a given degree of resistance, there was for each sand a definite maximum permissible water-cement ratio. Some of the structurally-sound sands, because of their fineness, had such high water requirements for the workability desired that they would not make durable concrete if used in the usual arbitrary proportions. Others were fairly well graded but actually produced mortars which were lacking in durability because of the structural weakness of many of the particles. Gradings which produced harsh porous mixtures resulted in mortars having low resistance to freezing, due probably to the presence of relatively large amounts of air and water voids.

For many of the aggregates there was a similarity in the manner in which failure occurred in the sodium sulphate and the freezing and thawing tests, although the breaking down of the particles proceeded at a much more rapid rate in the sulphate test. In general three to four times as many cycles were required to produce equal amounts of failure in the individual samples with the freezing and thawing as with the sodium sulphate.

The amount and manner of failure of the different coarse aggregates was not always the same in the soundness tests. Some remained unaffected up to 25 cycles of sodium-sulphate treatment, some broke down gradually by chipping or splitting apart at laminations, while others broke down almost completely. Therefore, when evaluating the results of such tests, consideration must be given not only to the amount of failure but also to the manner in which the disintegration of the particles occurs.

Materials which appear to be least resistant to the direct soundness tests are shale, chert, argillaceous limestone (water lime), and argillaceous sandstone. Of these, the shale and chert particles are most detrimental to mortar and concrete and, hence, the severe exposures should be avoided or at last restricted to relatively small amounts.

At this stage of the investigation it is not possible to predict the probable behavior of an aggregate in concrete or mortar solely on its behavior in the sodium-sulphate or freezing and thawing soundness tests. This must be interpreted in the light of the mineralogical composition of the aggregate tested. However, soundness tests are of value in detecting structural weaknesses in aggregates which under some conditions may seriously affect the permanence of concrete in which they are used. It is conservative to look with suspicion on those materials showing relatively poor results in the soundness

* Abstract of paper presented before Seventh Annual Convention, Assn. of Highway officials of the North Atlantic States.

TABLE I.—SUMMARY OF RESULTS OF SODIUM-SULPHATE TESTS.

Material	Number of Samples Tested	Number of Samples Showing a Greater Amount of Failure than Percentage Indicated									
		5 Cycles of Sodium Sulphate (*per cent.*)					10 Cycles of Sodium Sulphate (*per cent.*)				
		10%	12%	15%	20%	25%	10%	15%	20%	25%	30%
Fine aggregate	58	26 (45)	15 (26)	11 (19)	3 (5)	1 (2)	48 (83)	29 (50)	17 (29)	7 (12)	1 (2)
Pea gravel	7	4 (57)	3 (43)	3 (43)	3 (43)	0 (0)	6 (86)	4 (57)	4 (57)	4 (57)	3 (43)
Gravel	16	8 (50)	6 (37)	5 (31)	2 (12)	1 (6)	14 (88)	13 (81)	8 (50)	7 (44)	6 (37)
Crushed stone	24	2 (8)	2 (8)	1 (4)	1 (4)	1 (4)	9 (37)	7 (29)	3 (12)	3 (12)	2 (8)

Note.—Values in parentheses are percentages of total samples tested.

tests until such time as it is proved that they are suitable for use.

From the information thus far obtained, it is difficult to fix proper limits for the amount of failure to be permitted. A permissible loss of 15 to 20 per cent. by weight at 5 cycles in the sodium-sulphate test has been suggested for coarse, and 10 or 12 per cent. for fine aggregates. These values appear to be reasonable in the light of our present knowledge. However, in fixing limits for specification purposes, the important factors to be considered are the quality of the concrete in which the aggregate is to be used, the type of exposure to which it will be subjected, and the manner of failure of the unsound aggregate material. As has been pointed out, some of the cherts, shales and similar laminated

TABLE II.—SOUNDNESS AND MISCELLANEOUS TESTS OF FINE AGGREGATE.

Fine aggregates sampled during aggregate survey in the Northeastern States.

Sodium-sulphate accelerated soundness tests and freezing and thawing tests made as outlined in paper. The freezing and thawing tests were made essentially as outlined in the A. S. T. M. Standard Specifications for Drain Tile, Serial Designation C4-24, except that the aggregates were completely immersed during freezing. For some of the sands, soundness tests were made on the samples as received, the per cent. of failure being determined from the difference in fineness modulus before and after test.

Sieve analysis made in accordance with A. S. T. M. Standard Method of Test for Sieve Analysis of Aggregates for Concrete, Serial Designation C41-24, using Tyler standard screen-scale sieves.

Organic impurities determined in accordance with A. S. T. M. Standard Method of Test for Organic Impurities in Sands for Concrete, Serial Designation C40-27. The color value expresses the amount of organic matter in parts per 1,000,000 and is based on comparisons with tannic-acid solutions of known concentrations. Only sands showing color values of 250 parts per 1,000,000 or more are considered to contain harmful amounts of organic impurities.

Lot No.	Kind of Material	Sieve Analysis, Per Cent. by Weight Coarser than Sieve Indicated						Fineness Modulus	Unit Weight (*lb. per cu. ft.*)	Color Value (*parts per million*)	Soundness Tests—Per Cent. Failure by Weight After Number of Cycles Indicated											
											Sodium-Sulphate					Freezing-Thawing							
		100	48	28	14	8	4				5	10	15	20	25	10	20	30	40	50	60	70	80
10248	Sil	96	85	44	14	0	0	2.39	102	Trace	6	10	15	17	19	4	9	9	9	9	9	11	12
10278	Sil	94	77	48	34	21	8	2.82	.....	0	12	13	23	38	....	9	16	17	18	18	....	....	....
10279	Cal	97	88	71	55	35	13	3.59	117	0	17	21	26	34	....	9	13	16	17	18	26	27	27
10298	Sh.-Ls	94	76	47	27	14	4	2.63	.....	5	15	23	25	34	....	9	10	10	10	12	....	....	....
10299	Sh.-Ls	97	85	61	40	17	3	3.03	.....	0	9	18	26	31	32	6	9	11	12	12	14	14	14
10302	Cal	97	87	68	48	29	11	3.40	.....	0	10	20	26	30	31	8	11	15	15	15	15	16	16
10303	Sh.-Ls	97	90	72	41	18	5	3.23	.....	Trace	10	21	27	33	37	7	9	12	12	15	17	18	18
10304	Sil	87	30	3	1	0	0	1.21	103	0	13	14	18	21	....	12	15	17	18	20	22	22	23
10307	Sh.-Ls	97	96	91	75	46	21	4.26	.....	Trace	17	24	32	46	....	11	16	20	20	23	25	27	27
10308	Sil	98	88	59	36	15	2	2.98	105	Trace	8	11	15	22	....	6	6	6	7	9	....	....	....
10309	Sh.-Ls	97	93	70	26	10	3	2.99	.....	400	10	13	22	28	....	7	13	15	17	18	....	....	....
10312	Sil	95	75	45	26	15	6	2.62	112	0	6	12	15	22	....	3	5	9	9	9	....	....	....
10314	Sil	96	89	50	13	4	2	2.54	100	0	9	14	15	19	....	1	4	4	5	5	....	....	....
10315	Sh.-Sil	95	86	61	26	8	1	2.77	.....	5	5	12	18	26	....	6	9	10	11	11	11	10	11
10316	Sil.-Cal	98	95	73	36	17	4	3.23	.....	0	3	13	15	24	....	3	8	8	8	9	....	....	....
10317	Sil	99	95	52	12	5	2	2.65	101	0	5	11	15	22	....	4	4	5	7	9	....	....	....
10319	Sil	95	88	78	65	42	15	3.83	109	0	12	17	17	30	....	6	10	16	16	17	18	20	20
10322	Sil	90	59	26	17	12	6	2.18	114	0	8	12	14	20	....	12	13	13	15	15	....	....	....
10325	Sil.-Cal	95	88	58	35	20	7	3.03	.....	0	11	21	26	29	29	9	12	13	14	14	14	14	16
10329	Sh.-Sil.-Cal	98	93	58	15	4	1	2.69	102	Trace	20	30	36	52	....	8	10	13	18	20	....	....	....
10330	Ls	94	86	71	49	21	1	3.22	111	0	6	13	18	20	....	5	5	9	11	12	....	....	....
10333	Sh.-Sil.-Cal	98	93	50	16	6	3	2.66	104	Trace	16	20	23	32	....	17	21	23	23	24	....	....	....
10335	Granitic	78	23	1	0	0	0	1.02	105	0	21	27	30	31	....	14	29	31	31	31	....	....	....
10336	Cal	97	87	61	30	18	11	3.04	.....	Trace	16	17	20	32	....	7	7	9	13	13	....	....	....
10337	Sil	82	64	32	13	8	2	2.01	.....	0	3	14	19	26	....	4	4	5	6	6	....	....	....
10338	Cal	98	94	76	54	28	2	3.52	112	0	9	10	13	15	....	3	3	3	3	4	....	....	....
10340	Cal	98	88	65	38	21	8	3.18	109	Trace	13	22	32	43	....	7	13	14	14	15	....	....	....
10341	Cal.-Sil	98	90	52	19	3	0	2.62	104	Trace	11	13	16	20	....	5	8	10	10	11	....	....	....
10342	Cal	100	98	88	64	30	6	3.86	111	Trace	6	10	13	18	4	5	6	7	8	....	....	....	....
10346	Sh.-Cal	97	95	78	48	35	23	3.76	.....	Trace	15	22	27	31	33	9	14	17	18	19	19	19	19
10347	Cal	97	89	69	45	22	4	3.26	.....	0	11	14	18	24	....	6	10	10	10	10	....	....	....
10348	Cal.-Sil	94	73	39	25	17	8	2.56	.....	0	9	12	19	25	....	5	11	11	11	12	....	....	....
10349	Cal.-Sil	96	75	37	19	10	4	2.41	.....	0	11	26	29	52	....	10	15	17	17	19	....	....	....
10350	Cal.-Sil	96	84	61	41	26	11	3.19	.....	0	10	15	21	25	26	5	8	10	11	12	13	14	14
10356	Cal.-Sil	96	89	52	22	12	4	2.75	.....	Trace	29	34	40	42	....	16	20	20	21	23	....	....	....
10357	Cal.-Sil	99	98	88	48	11	1	3.45	.....	0	12	25	28	40	....	9	12	14	16	19	....	....	....
10363	Sil.-Cal	96	84	63	40	22	10	3.15	.....	Trace	17	24	30	34	36	10	17	20	20	28	28	29	29
10366	Sil.-Cal	97	92	78	51	21	2	3.41	.....	0	18	25	32	38	....	7	14	16	18	19	....	....	....
10367	Sil	99	98	85	48	15	6	3.51	.....	0	13	19	25	30	....	9	14	15	15	16	....	....	....
10370	Cal.-Sil	96	90	65	45	34	20	3.50	.....	0	9	14	18	23	24	6	9	12	13	13	13	13	13
10372	Sil.-Cal	96	88	67	47	28	9	3.35	.....	0	22	30	33	37	38	11	16	20	21	24	26	29	29
10375	Sil.-Cal	97	89	68	45	24	8	3.31	.....	Trace	13	20	25	29	30	6	11	13	15	16	16	16	20
10376	Sil.-Cal	97	82	52	30	11	1	2.73	.....	0	4	12	14	16	....	5	8	8	9	10	....	....	....
10378	Sil.-Cal	96	89	74	51	19	1	3.30	.....	0	4	8	12	16	....	3	3	6	8	9	....	....	....
10379	Sil.-Cal	95	85	58	34	18	4	2.94	.....	0	5	14	16	20	....	3	6	6	6	6	....	....	....
10380	Sil.-Cal	97	84	43	31	23	10	2.88	.....	0	10	17	21	23	26	6	9	10	10	10	10	11	11
10385	Cal	98	97	90	73	49	20	4.27	115	0	11	18	24	29	34	7	13	14	14	17	17	18	18
10387	Sil	96	87	65	43	21	4	3.16	113	Trace	3	7	11	18	....	1	1	1	2	2	....	....	....
10389	Sil.-Cal	96	87	68	46	21	2	3.20	.....	Trace	18	27	33	38	....	6	12	14	15	15	....	....	....
10391	Granitic	90	71	37	15	7	3	2.25	.....	Trace	6	8	8	12	....	0	0	0	1	3	....	....	....
10413	Sil	98	91	71	47	22	1	3.30	.....	Trace	5	10	11	20	20	1	2	5	5	5	5	....	....
10414	Sil	96	78	55	40	26	11	3.06	.....	Trace	11	18	19	30	33	7	10	13	15	18	18	18	18
10563	Sil	95	81	54	32	16	4	2.82	.....	Trace	15	27	33	35	42	9	10	12	13	14	15	....	....
Lab.	Ls. Scrgs	86	82	74	62	41	5	3.50	.....	.....	12	19	24	24	26	5	6	12	14	15	15	....	....
Lab.	Granite Scrgs	93	79	47	28	12	0	2.59	.....	.....	7	13	17	18	20	3	4	8	8	9	9	....	....
Lab.	Elgin Sand	97	86	53	34	15	0	2.85	112	.....	5	9	11	12	20	4	4	4	7	8	8	....	....
Lab.	Ottawa Std. Sand	100	100	100	0	0	0	2.65	104	.....	3	4	4	6	6	0	0	0	2	2	2	....	....
Lab.	Ottawa Mine Run Sand	94	76	7	0	0	0	1.77	109	.....	4	13	14¶	14	15	2	3	6	7	7	7	....	....

materials are the most undesirable and should be allowed only in small amounts. Dirty and coated aggregates are also to be avoided, as it appears from our general studies that these, because of their detrimental effect on the quality of the paste, have a much greater influence on the permanence of concrete than small amounts of unsound materials.

As significant and interesting as these studies are in showing the important effect of the aggregate in quality on the durability of concrete, they should not be allowed to divert attention from the necessity for proper construction methods. No amount of care in the selection of materials will produce durable concrete pavements unless the materials are properly proportioned, mixed, placed, and opportunity provided for ample curing.

The importance of the quality of the cement-water paste was brought out by these tests. This shows not only the need for proper quantity of water at the mixer but also the necessity of giving attention to consistency and methods of placing and finishing to avoid unbalancing the mix after it is in place. Any operation of placing or finishing which causes segregation or brings water to the surface will result in greatly reduced resistance to wear and weather.

Other of our current investigations have shown the advantage to be gained by extending the moist-curing period, particularly in developing watertightness and resistance to freezing and thawing. Probably no phase of the construction operations has a greater effect on the life of pavements than the provisions made for curing.

Soundness Tests of Aggregate

Number of Samples Investigated.—Approximately 58 samples of fine aggregate and 47 of coarse were tested for soundness by the sodium-sulphate accelerated soundness test and by direct freezing and thawing. Duplicate tests were run on approximately 20 of the coarse aggregates. A number of these samples (29 fine and 12 coarse) were incorporated in mortar and concrete cubes which were studied separately and also compared with the results of tests upon the aggregate alone.

The results of sodium-sulphate and direct freezing and thawing tests on the various fine and coarse aggregates are reported in Tables II and III. Details of the tests are given in the notes accompanying the tables. The large number of samples under investigation, the development of suitable methods of test, and the rather complicated procedure involved in tests of this nature necessarily meant a long and difficult task to make soundness tests on

TABLE III.—SOUNDNESS TESTS OF COARSE AGGREGATES.
Tests Made on Approximately 1500-gram Samples

Lot No.	Soundness Tests Per Cent. Failure by Weight After Number of Cycles Indicated																			
	Sodium-Sulphate					Freezing-Thawing														
	5	10	15	20	25	5	10	15	20	25	30	40	50	60	70	80	90	100	110	120
Pea Gravel (Glacial: Sandstone, Limestone, Shale, Dolomite, Granite, Quartz, etc.)																				
10310	12	27	44	52	56	.....	6	.....	12	.....	15	47	[2]	.....	.....	.....	.....	.....	.....	.....
10306	5	7	18	32	35	.....	5	.....	12	.....	16	23	25	26	27	27	[2]	.....	.....	.....
10323	22	34	42	48	51	.....	9	.....	15	.....	18	23	24	26	27	27	[2]	.....	.....	.....
10324	22	38	48	56	61	.....	7	.....	15	.....	21	53	[2]	.....	.....	.....	.....	.....	.....	.....
10343	6	14	19	30	34	.....	3	.....	5	.....	8	16	17	18	19	20	[2]	.....	.....	.....
10393	22	31	38	48	50	.....	10	.....	17	.....	20	26	28	30	31	31	[2]	.....	.....	.....
10480	8	12	20	25	31	OK	OK	2	2	4	5	6	10	12	12	12	15	15	[2]	.....
Gravel (Glacial: Sandstone, Limestone, Shale, Dolomite, Granite, Quartz, etc.)																				
10156	4[1]	13[1]	24[1]	38[1]	40	10	15	15	20	20	20	25	30	30	32	35	[2]	.....	.....	.....
10305[1]	60	[2]	.....	.....	.....	OK	9	10	31	32	37	[2]	.....	.....	.....	.....	.....	.....	.....	.....
10313	15[1]	41[1]	47	.....	.....	20	25	30	30	35	35	40	40	40	40	40	[2]	.....	.....	.....
10318	20[1]	37	50[1]	50[1]	.....	12	15	15	20	20	27	30	35	40	40	40	[2]	.....	.....	.....
10327	23	70	[2]	.....	.....	5	10	15	20	22	25	25	35	35	40	45	[2]	.....	.....	.....
10328	5[1]	20[1]	27[1]	38[1]	41	OK	10	15	20	30	35	50	50	55	55	55	[2]	.....	.....	.....
10339	6[1]	23[1]	30[1]	35[1]	.....	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	[2]	.....	.....	.....
10351	20[1]	40[1]	59[1]	60	.....	10	15	20	20	25	25	30	40	45	45	[2]	.....	.....	.....	.....
10373	10[1]	20[1]	35[1]	50	.....	10	15	15	15	15	15	15	15	25	25	40	[2]	.....	.....	.....
10383	10[1]	27[1]	35[1]	45[1]	51[1]	OK	7	10	15	20	25	30	35	40	50	50	[2]	.....	.....	.....
10384	12[1]	15[1]	27[1]	35[1]	50	OK	OK	OK	OK	OK	3	3	3	3	3	10	10	10	10	10
10388	20	65	[2]	.....	.....	.....	10	10	15	25	25	30	32	32	32	33	[2]	.....	.....	.....
10390	12[1]	25[1]	35[1]	43[1]	45[1]	OK	1	1	7	11	11	11	15	20	20	[2]	.....	.....	.....	.....
10395	10[1]	18[1]	19	29	.....	OK	OK	5	5	5	10	12	15	15	20	25	25	25	25	25
10476	OK[1]	6[1]	14[1]	14[1]	18[1]	OK[1]	OK[1]	OK[1]	OK[1]	OK[1]	4[1]	4[1]	5[1]	9[1]	9[1]	9[1]	10[1]	10[1]	[2]	.....
Elgin	3	8	16	17	28	OK	OK	5	5	5	5	5	8	9	10	10	11	11	[2]	.....
Crushed Stone (Limestone, Dolomite, Dolomitic Limestone, Argillaceous Limestone, Granite, etc.)																				
10310-11	4	12	14	42	44	OK	8	9	15	19	21	22	23	23	23	.....	[2]	.....	.....	.....
10320	1[1]	3[1]	5[1]	7[1]	8[1]	OK	1	1	1	5	6	6	6	10	10	10	[2]	.....	.....	.....
10321	1	3	8	16	25	OK	OK	OK	OK	3	4	4	4	5	7	[2]	.....	.....	.....	.....
10326	2[1]	6[1]	23[1]	28[1]	40	OK	OK	OK	OK	OK	10	10	10	10	10	10	10	10	10	10
10331	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	5	10	10	10	10	10	[2]	.....	.....	.....
10332	6[1]	9[1]	14[1]	18[1]	22	OK	10	10	20	25	25	25	25	25	25	25	25	25	25	25
10334	2[1]	16[1]	26[1]	38[1]	45	OK	5	5	10	12	15	20	25	30	35	35	[2]	.....	.....	.....
10344	OK	10	15	25	40	OK	7	7	10	20	20	20	20	25	30	[2]	.....	.....	.....	.....
10345	14[1]	17[1]	30[1]	40	40	OK	6	6	6	6	6	15	15	15	15	15	[2]	.....	.....	.....
10358	28[1]	54[1]	66	.....	.....	OK	6	15	20	25	25	30	35	40	[2]	.....	.....	.....	.....	.....
10359	OK	5	5	10	15	2	10	10	20	25	25	30	30	30	35	35	[2]	.....	.....	.....
10360	OK	10	15	20	25	OK	OK	OK	OK	OK	OK	OK	OK	OK	5	10	10	10	10	10
10362	3[1]	16[1]	28[1]	36[1]	45	OK	3	6	10	10	10	15	20	35	[2]	.....	.....	.....	.....	.....
10364	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	15	20	20	25	25	25	dis.
10368	OK	10	20	20	30	3	3	5	5	5	7	10	10	10	10	10	10	10	10	10
10369	3	5	7	15	20	OK	OK	6	6	10	15	20	25	25	25	25	30	30	[2]	.....
10371	2	5	10	25	40	OK	OK	10	10	15	20	20	20	20	20	20	20	20	20	20
10374	6[1]	27[1]	36[1]	40	50	5	5	10	15	15	15	15	20	25	35	[2]	.....	.....	.....	.....
10377	3	14	25	40	60	OK	OK	OK	3	3	3	3	3	3	3	10	10	10	10	10
10381	10	35	60	[2]	.....	3	5	5	10	10	15	25	35	40	[2]	.....	.....	.....	.....	.....
10382	3[1]	5[1]	7[1]	10[1]	18[1]	OK	5	5	7	10	15	15	20	20	20	25	[2]	.....	.....	.....
10386	OK[1]	5[1]	23[1]	40[1]	45	OK	OK	OK	OK	OK	10	15	15	20	30	35	[2]	.....	.....	.....
10392	3[1]	17[1]	25[1]	25[1]	32[1]	OK	OK	10	10	12	15	20	20	25	30	30	[2]	.....	.....	.....

[1]Average of 2 tests. [2]Discontinued.

TABLE IV.—RESULTS OF PETROLOGICAL COUNTS ON SANDS.

A 200-gram sample of each sand was separated into six sizes (No. 4, ⅜ in.; No. 8, No. 4; No. 14, No. 8; No. 28, No. 14; No. 48, No. 28; and No. 100, No. 48) on Tyler standard screen-scale sieves. Each size was examined separately. Where the particles were coarser than the No. 28 sieve, separation was made by means of forceps and a hand lens. The smaller sizes were examined under the petrographic microscope, six fields being counted. The various percentages of suspected non-durable particles in the separated sizes were weighed to obtain the amount of unsound particles in the total sample.

Lot No.	Classification of Sand	Non-Durable Material (*per cent. by weight of total sample*)									Total Unsound Material
					Argillaceous			Weathered			
		Shale	Chert	Ochre	Sandstone	Limestone	Poorly Cemented Material	Sandstone	Granite	Schist	
10248	Siliceous	0.2			2.5		4.1				6.6+
10278	Weathered Granite	5.9	Trace	5.6				1.4	11.7		24.8
10279	Calcareous-Siliceous	0.7	1.2		5.4	1.6		5.0			13.9
10298	Calcareous-Siliceous	2.2	6.3		18.1	1.9					28.5
10299	Siliceous-Calcareous	2.1	1.7		21.1	2.8		0.5			28.3
10302	Calcareous-Siliceous	0.05	Trace	Trace		9.1		0.5			9.6+
10303	Siliceous-Calcareous	5.3	1.0		16.6	5.2+		Trace			28.2+
10304	Siliceous		0.2+			0.2					0.4+
10307	Siliceous	0.5	1.2		3.0	5.6		0.2	1.0		11.0
10308	Siliceous-Calcareous	1.4+				18.8					20.2+
10309	Siliceous-Calcareous	3.6	0.2		16.6	Trace					20.6+
10312	Calcareous-Siliceous					14.4	0.35				14.8
10314	Calcareous-Siliceous		10.8+		12.2	0.3					23.3+
10315	Calcareous-Siliceous	4.2	3.3+		6.1						13.5
10316	Calcareous	Trace				5.5+					5.5+
10317	Calcareous-Siliceous	5.6					0.1+	0.1+			5.7+
10319	Calcareous-Siliceous	2.0			2.0		2.6	2.6	3.1		12.3
10322	Siliceous-Calcareous	Trace	Trace			4.3	0.8				5.1+
10325	Calcareous		0.1+	0.2+		7.7					8.0+
10329	Shale-Calcareous	33.6		Trace		Trace					33.6+
10333	Shale-Calcareous	15.1	0.3+	Trace			5.4				20.9
10335	Calcareous-Siliceous		Trace		0.3						0.3+
10336	Calcareous	6.3	0.6		2.5		0.7	0.8			11.0+
10338	Calcareous	Trace	2.4+		4.1+		0.3	2.4			9.2+
10340	Calcareous	8.1	1.1+		9.2		1.0				19.4+
10341	Calcareous-Granitic	1.5				2.0		3.1	2.1		8.7
10342	Calcareous-Siliceous	0.3+			0.1			7.0	1.1		8.6+
10346	Shale-Calcareous	15.2		0.15+		7.9					23.4
10347	Calcareous-Siliceous	Trace				16.1+					16.1+
10348	Calcareous	2.3					4.7	0.3			7.3
10349	Calcareous		1.5+		3.2	5.5	3.9				14.1+
10350	Calcareous	0.5+			0.2+	14.4	0.2+				15.2+
10356	Shale-Calcareous	18.9		Trace		3.0+	0.3				22.3+
10357	Calcareous	6.3	Trace			1.5+	5.6		0.3		13.7+
10363	Shale-Calcareous	20.8	0.2		0.4		0.3	2.4			24.2
10366	Calcareous	3.1	Trace			10.0	Trace	1.3			14.3+
10367	Shale-Siliceous	19.5					0.9	2.9		2.2	25.6
10370	Calcareous	6.5	Trace		1.7						8.2+
10372	Calcareous-Shale	14.2		Trace		Trace	Trace	0.3	1.7		16.2+
10375	Calcareous	7.3+	0.2+			8.2		4.7			20.3+
10376	Calcareous	1.6					0.6	0.3	3.9	0.7	7.2+
10378	Siliceous-Calcareous	3.8			1.5		0.7	0.3		12.9	19.3+
10379	Calcareous	1.3	4.0		5.8		2.1	0.8			14.1+
10385	Calcareous	1.4	Trace		8.1		0.1	0.8	2.3		12.7+
10387	Calcareous	2.1	0.5		4.6						7.3
10389	Calcareous-Siliceous	7.6	0.5	0.9	0.9	6.1		2.6			17.7
10391	Granite		Trace				Trace				Trace
10414	Siliceous-Calcareous	1.7	Trace		6.7						8.4+
10562	Calcareous-Siliceous		4.1		1.1				1.9		7.2
10563	Shale-Calcareous	14.5	0.4		9.0	1.4+		0.8			26.2+
Elgin	Calcareous-Siliceous	0.3	4.1		0.3			1.6	1.8		8.2

the individual aggregates and to correlate the results with their behavior in mortar and concrete. The results indicate possible reasons for the unsatisfactory performance of some of the materials in concrete structures but they should not be used as a basis of acceptance for individual aggregates until further work has been done.

Behavior of Aggregates in Direct Soundness Tests.—A study of the data in Table II shows that there was in general considerable similarity in the results obtained in the sodium-sulphate and direct freezing and thawing tests on the different fine aggregates. It will be noted that the breaking down of the particles occurred at a much slower rate in the freezing and thawing tests than in the sodium-sulphate. A study of the results for all fine aggregates showed that to produce equal amounts of failure approximately three times as many cycles of freezing and thawing were required as for sodium-sulphate tests.

There were wide differences in the manner in which the various coarse aggregates behaved in the soundness tests as may be seen from Table III. Some remained unaffected up to 25 cycles of the sodium-sulphate treatment, some broke down gradually by chipping or by splitting apart at laminations, while others broke down completely. With the coarse aggregates the ratio of freezing and thawing cycles to cycles of sodium sulphate for equal amounts of failure was more variable than for the fine aggregates, ranging from about 1 to 1 to 10 to 1 with an average value of about 4 to 1. The fine aggregates, in general, broke down more uniformly than the coarse, probably because of their smaller size; such inequalities as might occur in the coarse aggregate had evidently been largely obliterated by the forces of nature during the process of reduction in size.

The results show that the sodium-sulphate soundness test is a severe test, only five or ten cycles being required to produce considerable failure in many of the aggregates tested. The differences in the manner of failure observed with some of the coarse aggregates in this test indicate that, when evaluating the results, consideration must be given not only to the amount of failure but also to the manner of its occurrence. Failure by chipping, splitting at laminations, or incipient cracks would not be expected to have as serious an effect on the permanence of concrete as complete disintegration of the particles. Further study is desirable to determine the minimum number of cycles to be used. From the standpoint of expediency, five cycles are preferable to a greater number. In general, the results obtained by direct freezing and thawing of the

aggregates alone, as employed in these tests, appear to be similar in character if not in degree to those obtained by the sodium-sulphate method.

Materials Failing in Soundness Tests.—Materials which appear to be least resistant to sodium-sulphate and to direct freezing and thawing action are shale, chert, argillaceous limestone, weathered granite, and argillaceous sandstone. Of these, shale and chert particles appear to be the most detrimental to mortar and concrete and are to be avoided or at least restricted to relatively small amounts. While there are differences in shales, most varieties weather readily and cause pitting and cracking in exposed concrete structures. Cherts are also quite variable in character. Some varieties break up readily when used in concrete exposed to freezing and thawing and are a frequent cause of pop-outs. Flint and chert particles may not only cause pop-outs, but may also prove troublesome by their tendency to produce scaling of the mortar in which they are embedded and with which they do not form a good bond, especially in overwet mixes. The lack of bond permits the penetration of water and thus promotes failure by freezing. Many instances were noted during field investigations where coarse aggregate contained these siliceous materials in sizes larger than 1½ in.

Limits of Failure in Accelerated Soundness Test.—The lack of complete information on the effect in mortar and concrete under various conditions of exposure of materials failing in the sodium-sulphate soundness test makes it difficult to set limits for the amount of failure to be permitted in this test. A permissible loss of 15 to 20 per cent. by weight at five cycles has been suggested for coarse aggregates and 10 or 12 per cent. for fine. In this connection the brief summary of results in Table I is of interest.

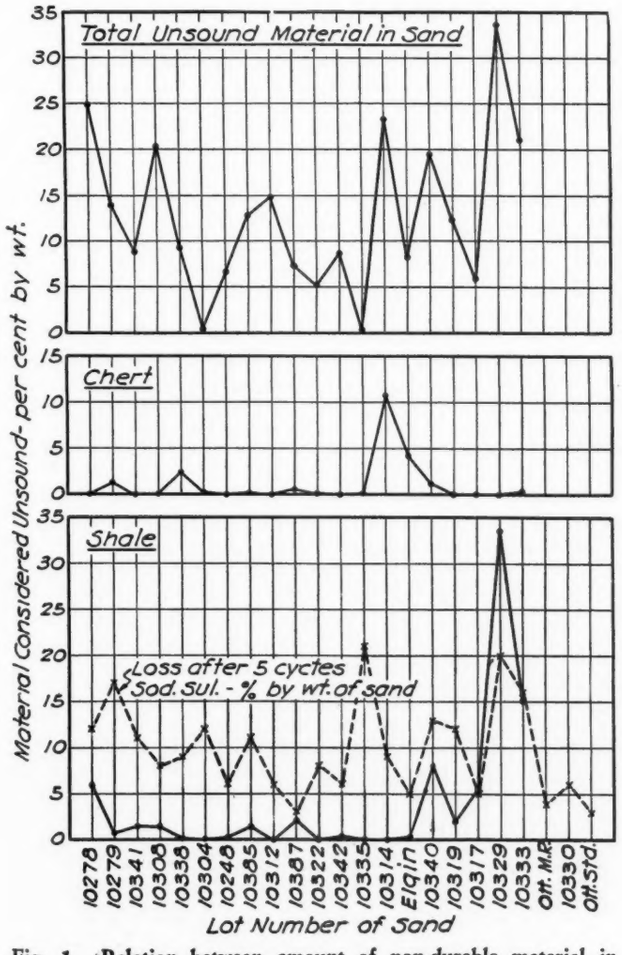


Fig. 1. Relation between amount of non-durable material in sands and their mortar losses at 200 cycles of freezing and thawing.

If 12 per cent. failure by weight is permitted for fine aggregate and 15 per cent. by weight for coarse aggregate, after five cycles of the sodium-sulphate soundness test, 15 or 26 per cent. of the 58 samples of fine aggregate, 3 or 43 per cent. of the 7 samples of pea gravel, 5 or 31 per cent. of the 16 samples of gravel, and 1 or 4 per cent. of the 24 samples of crushed stone tested would be judged lacking in durability. If 20 per cent. failure at ten cycles were permitted for both fine and coarse aggregates, the number of samples of each type failing to meet this requirement would be somewhat greater than in the previous case. As pointed out previously, many of these samples were suspected of containing considerable amounts of non-durable materials, so it is not surprising that the number of samples failing to meet the above requirements was relatively high. In fixing limits for specification purposes there are several factors to be considered, the most important of which are: the quality of the concrete in which the aggregate will be used, the type of exposure to which the concrete will be subjected, the character of the unsound material, and its manner of failure.

Petrographic Examination

The sands were separated into six sizes on Tyler standard screen-scale sieves, examined macroscopically and microscopically, and a count was made of suspected non-durable particles. Table IV contains data of petrological counts on the majority of the sands used in this investigation. Listed under separate headings are the percentages of particles that might be expected to prove harmful in mortar or concrete. As it was impossible to test for soundness of each kind of material judged to be unsound, the selection of these particles in the individual sands was made on the basis of a knowledge of the behavior of materials of similar nature. For this reason, the count may be high in some cases and in others low.

Data from Table IV are compared in Fig. 1 with the results obtained with several of the sands in the sodium-sulphate tests and in mortar cubes. It appears from these and other data in this investigation that the most injurious of the non-durable materials is shale. Shale, when present in sands in quantities exceeding 3 to 5 per cent., produced mortars having relatively poor resistance to freezing, even though the sands were used in relatively rich mixes. Some of the sands examined contained over 20 per cent. shale, one as much as 33 per cent.

Freezing and Thawing Tests of Cubes

Making, Curing and Testing Mortar Cubes.—Twenty-four samples of sand, covering a considerable range in grading and other characteristics, were made into 2-in. cubes, using mortars having nominal water contents of 4½, 5½, 7 and 9 gal. per

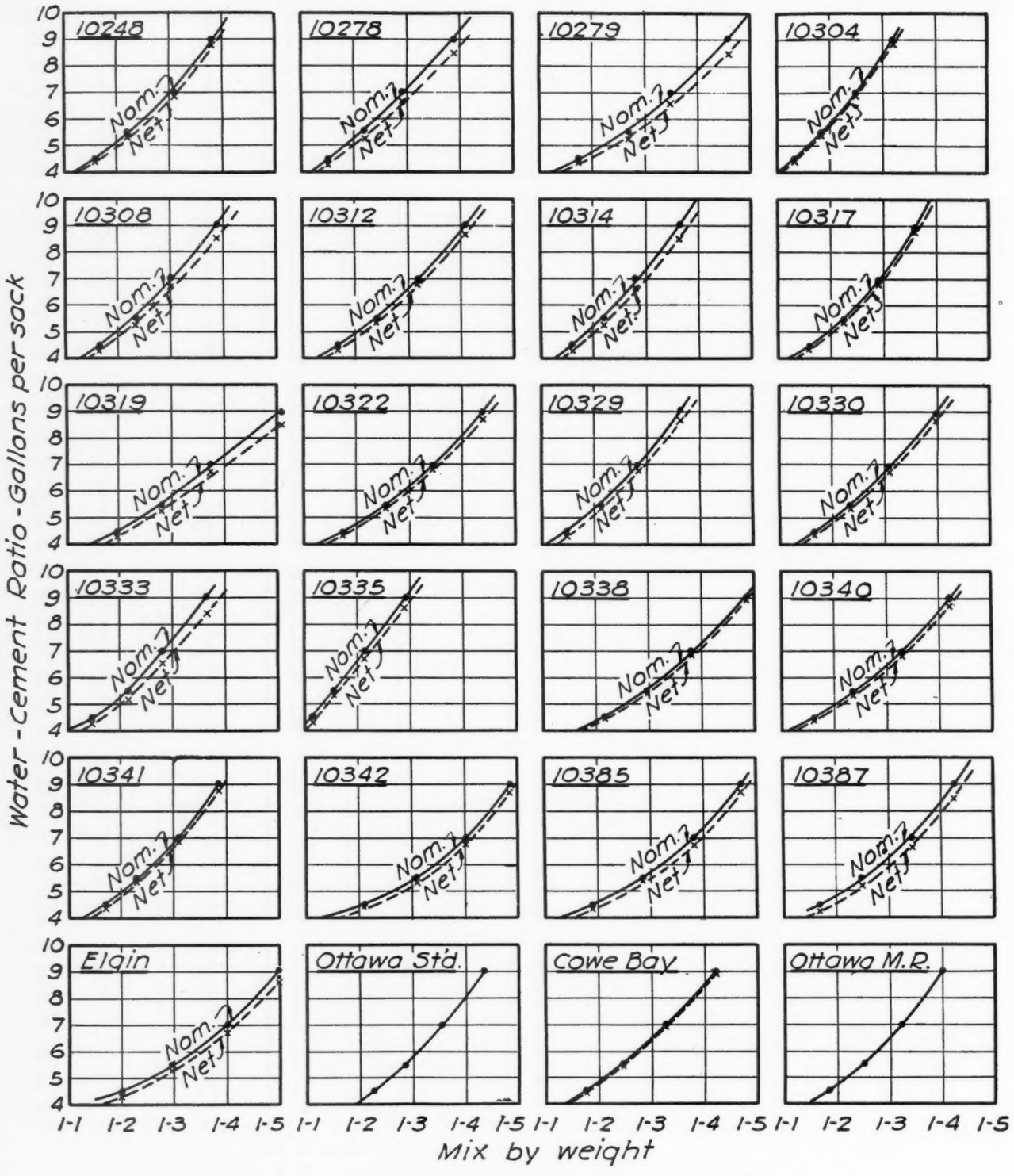


Fig. 2. Water-cement-ratio mix relations for mortars of constant flow.

sack of cement. For purposes of comparison, standard Ottawa, mine-run Ottawa, Elgin, and Cowe Bay sands were included. In making the mortar cubes, the cement and water in the proper proportions were mixed to form a water-cement paste, to which was added the room-dry sand until the desired consistency was obtained. The consistency was measured with a flow table, using a 70-mm. by 100-mm. truncated cone 50 mm. high and thirty $\frac{1}{8}$-in. drops in 30 sec. The flow used was 150 mm. $\pm$ 5. With this flow the consistency was such that the mortars could be readily molded by puddling lightly with the fingers without appreciable segregation of the mixing water. The curves in Fig. 2 show the relation between the mix by weight and the water-cement ratio for each of the sands used. With this method of mixing, the different sands produced mortars of varying cement content, even though the water-

cement ratio was the same in each case, and this fact should be kept in mind when making comparisons of the results.

The cubes were cured 1 day in molds, 13 days in a moist room, and 14 days in laboratory air. When 28 days old they were soaked in water for 72 hr., chilled in cold water, and then frozen in the saturated condition in a room, the temperature of which was maintained at from — 5 deg. F. to — 20 deg. F. During freezing, the cubes were immersed in water to a depth of about ½ in. in covered metal pans. When thoroughly frozen, they were thawed by immersing the pans in water which was maintained between 70 deg. F. and 80 deg. F. by means of circulating warm water. After various cycles of this treatment, the cubes were cleaned with compressed air, weighed, and their condition noted.

There were nine cubes for each water-cement ratio in the freezing and thawing tests. At different stages six of the nine cubes were tested in compression in sets of three. The resulting strengths were compared with the strengths of companion cubes stored in the moist room at 70 deg. F. from the time they were made until they were tested. Data of the compression tests were not in form for inclusion in this report.

General Relationships in Tests.—The effect of the freezing treatment was judged by the resulting changes in weight and by the general appearance of the cubes. An indication of the type and range of results secured may be had from Fig. 3 which shows data of tests on sand 10279, a calcareous sand, and sand 10333, a shaly, siliceous-calcareous sand. The diagrams in the left-hand portion of the figure show for each of the four water-cement ratios the relation between the percentage loss by weight of the specimens and the number of cycles of freezing and thawing, while those in the right-hand portion show the relation between loss in weight and water-cement ratio at 80, 140 and 200 cycles. The last-named number of cycles was the maximum attained at the time the data were plotted. Similar curves were plotted for each sand tested and the data taken from them and from the water-cement ratio-mix curves in Fig. 2 were used in making comparisons of the results. The upper part of Fig. 4 shows curves similar to those in Fig. 3 based on the average results for the ten sands having the lowest weight losses at 200 cycles in the 7-gal. cubes. (See Fig. 5.) The lower part of Fig. 4 shows the average results for all sands except standard Ottawa and Ottawa mine run.

In considering the data in these and the following figures, it will be helpful to have some idea of the meaning of the various percentages of weight loss in terms of the general appearance of the mortar cubes. A 0.3- to 0.5-per cent. loss represents the beginning of visual disintegration while a 1-per cent. loss represents that stage of disintegration at which the original surface of the specimen begins to disappear. With a 1½-per cent. loss, the original surface is gone, the disintegration having reached an average depth of about 1/16 in. It is impossible to give an absolutely accurate description of the failure corresponding to a given weight loss because of the fact that many of the losses recorded came almost entirely from the submerged portion of the cube while in other cases the disintegration was more general over the entire surface area. For this reason a 1-per cent. loss in some cubes means more serious disintegration than a 1-per cent. loss in others where the disintegration was distributed over a greater amount of surface.

The most significant feature of Figs. 3 and 4 is the marked influence of the water-cement ratio on the behavior of the cubes under the freezing and thawing treatment. Under the conditions of these tests, the 9-gal. cubes (lean mix) began to lose weight almost immediately, the loss in weight increasing rapidly with an increase in the number of cycles. In the 7-gal. cubes the losses in weight were generally very much less than in the corresponding 9-gal. cubes and occurred at a much slower rate. The 5½- and 4½-gal. cubes did not show any signs of disintegration in most cases until after about 80 cycles, and their weight losses were relatively small even at 200 cycles, the maximum number to date. In these low water-cement ratios the protection afforded by the paste was such that even those cubes containing considerable amounts of non-durable shale particles were but little affected at 200 cycles.

The amount of loss for any given water-cement ratio and number of cycles was in general different for each of the sands. Consequently, the cubes made from some sands showed lower losses than those of lower water ratio made from other sands.

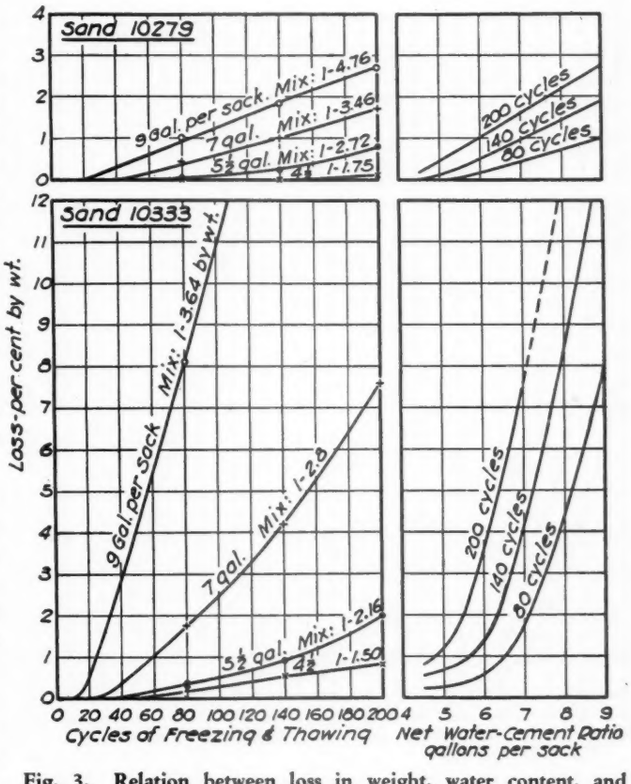


Fig. 3. Relation between loss in weight, water content, and number of cycles in freezing and thawing tests of 2-in. mortar cubes.

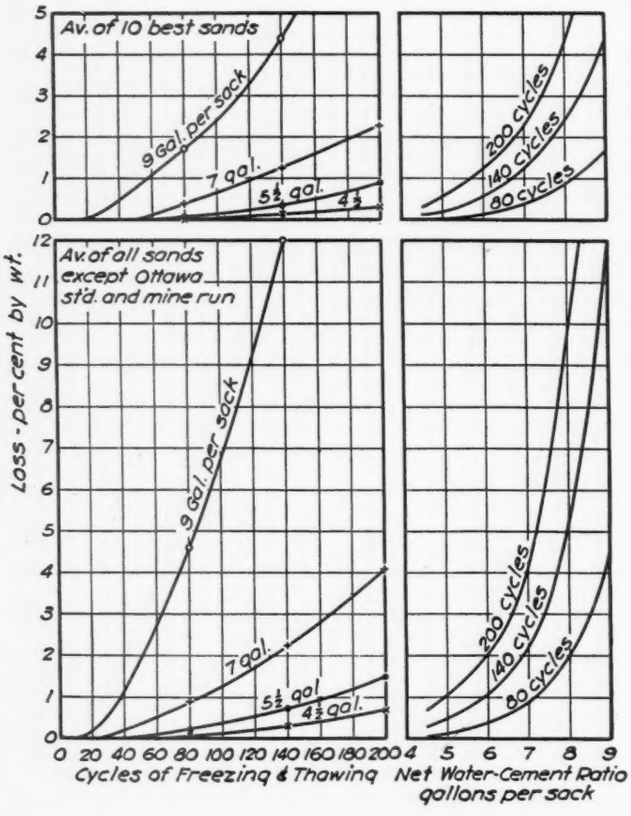


Fig. 4. Average relations between loss in weight, water content, and number of cycles in freezing and thawing tests of 2-in. mortar cubes.

Comparison of Freezing and Thawing Tests.—A general comparison of the 2-in. mortar cubes upon freezing and thawing may be obtained from Fig. 5, which shows the amounts of disintegration as indicated by their losses in weight at 80, 140 and 200 cycles for each of the four water-cement ratios. The various sands are arranged in ascending order based on the percentage of loss in weight of the 7-gal. cubes at 200 cycles. The 7-gal. cubes were taken as the basis of comparison because the weight losses of the cubes of lower water-cement ratio were relatively small and, therefore, more likely to be influenced by experimental errors, and because, at this stage of the tests, the 9-gal. cubes had disintegrated to such an extent that it was not practicable to consider them. Some idea of the rapidity of the failure of the lean 9-gal. mixes can be had from the two upper sets of diagrams in Fig. 5, which show the losses in weight at 80 and 140 cycles. At 200 cycles many of the 9-gal. cubes showed such advanced disintegration that the plotted points fell outside the limits of the lower diagram and therefore none of the 9-gal. losses were included.

The two most significant features of Fig. 5 are the similarity in the arrangement of the various sands in the three groups of diagrams as indicated by the parallelism of the curves for the different water-cement ratios and the relatively low losses exhibited by the 4½- and 5-gal. cubes at all stages of the tests. In order to show the effect of other factors involved and to facilitate comparisons, the fineness moduli of the sands, the percentages of failure by weight after 5 cycles of sodium-sulphate treatment, and the mixes for the 7-gal. cubes are included in the figures. The figure also includes a few tests of Cowe Bay sand, both untreated and treated with different amounts of tannic acid by weight of sand. Due to the difficulty encountered in making 2-in. cubes with this sand when treated with the two higher percentages of tannic acid, 2-in. by 4-in. cylinders were used instead. In making studies of the data presented in Fig. 5, reference should also be made to Fig. 1 in which the sands have been arranged in the same order for the purpose of bringing out the effect of the suspected nondurable materials they contained. Only five of the sands in this group of tests showed more than 12 per cent. loss in five cycles of the sodium-sulphate test.

Performance of Certain Sands.—Of particular interest are the possible reasons for the positions occupied by the various sands in Fig. 5. Especially significant is the fact that sands 10317, 10340, 10333, and 10329, which are among those showing the highest weight losses in the mortar cubes, also contained the highest percentages of shale. Sands 10317, 10333, and 10329 were quite similar in grading, there being a preponderance of the No. 48 to No. 14 particles and their resulting 7-gal. mixes were richer than most of the other sands tested. Sands 10329 and 10333 showed high percentages of failure in the sodium-sulphate test.

The high losses shown by the mortars from the Ottawa sands and from sample 10330 (stone screenings) is believed to be due in part to the surface characteristics and low absorption of the particles and in part to the relatively high proportion of air voids in the resulting mortars. These aggregates showed low losses in the sodium-sulphate test.

The position of Elgin sand and sand 10319 in the diagram is believed to be due primarily to the lean mixtures of the 7-gal. cubes resulting from their coarse gradation. It also should not be overlooked that Elgin sand contains 5 per cent. unsound chert and that the relatively high percentage of failure of sand 10319 in the sodium-sulphate tests indicates the presence of some constituent susceptible of early failure.

Sand 10335, although having 21 per cent. failure by weight in the sodium-sulphate soundness test, occupies a position near the middle of the group. This was a very fine sand and produced the richest mortar of any sand tested. Its high percentage of failure in the sodium-sulphate test is probably caused by the loss of fine particles during decantation and washing.

Of the sands at the left-hand portion of Fig. 5 there are only one or two that need special comment. Sand 10278 is first at the left, although according to the petrographical count, it contained 6 per cent. shale and approximately 5 per cent. ochre and in the sodium-sulphate test showed 12 per cent. loss, which indicated the presence of materials susceptible of early failure. The 7-gal. mix from this sand was richer in cement than many of the

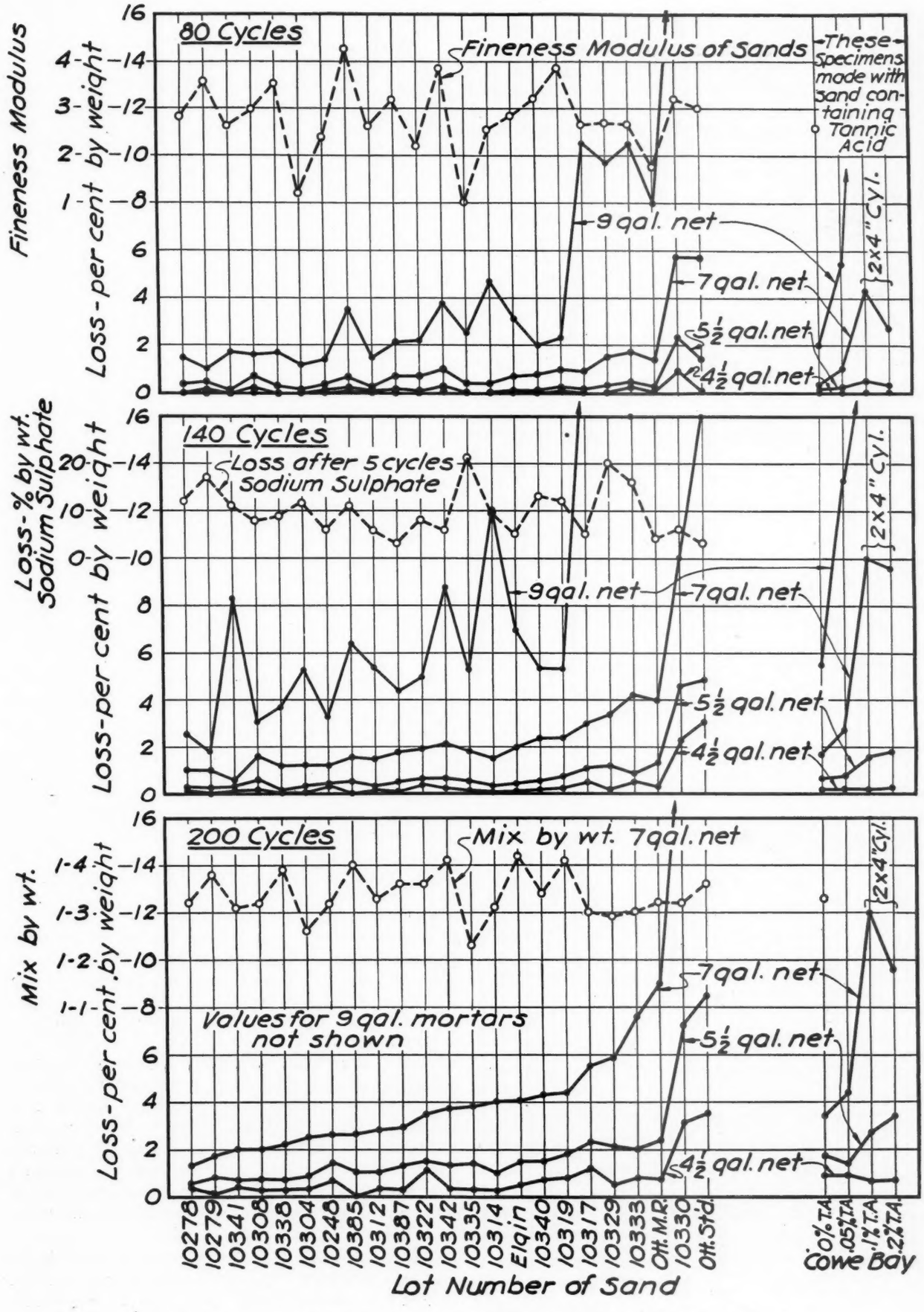


Fig. 5. Loss in weight of 2-in. mortar cubes at 80, 140 and 200 cycles of freezing and thawing.

others; otherwise there is no apparent reason for its good performance. Sand 10279, the second from the left, was a coarse sand which showed 17 per cent. failure in the sodium-sulphate test. As this sand contained only small amounts of shale and chert, it appears that the other constituents considered as non-durable were not detrimental to the mortar cubes upon freezing and thawing.

It is apparent from the foregoing results that, in spite of one or two inconsistencies, the sands containing percentages of shale in excess of about 3 to 5 did not produce mortars possessing high resistance to repeated freezing and thawing, particularly when the water-cement ratio exceeded 5½ gal. per sack.

Water-Cement Ratios and Permanence.—Although, as pointed out in the discussion of Fig. 3, none of the mortars withstood as many as 200 cycles of freezing and thawing without showing some signs of failure, however slight, all showed greatly increased resistance to disintegration as the water-cement ratio decreased. It appears from these results that none of the mortars under the conditions of the tests were absolutely permanent, although most of the 4½- and 5½-gal. mortars would be considered relatively permanent in the usual sense of the term. It is also evident that the permanency of any of the mortars was primarily dependent on its water-cement ratio regardless of the quality of the sand which it contained. It is possible, therefore, to classify the sands according to the maximum permissible water-cement ratio which may be used for a given degree of permanence. Such a classification is given in Fig. 6, which shows the maximum permissible water-cement ratios for 0.5-per cent., 1-per cent., and 1½-per cent. losses in weight of the mortar cubes at 140 and 200 cycles, the sands being arranged on the basis of their water-cement-ratio requirements for a 1-per cent. loss in both diagrams. The mixes by weight, corresponding to the maximum permissible water-cement ratios for a 1-per cent. loss, are included on each of the two diagrams. While there are some differences in the order of the sands at 140 and 200 cycles, it will be noted that there are no important changes in their arrangement and that the classifications are in general agreement with that shown in Fig. 5.

The method of classification used in Fig. 6 has a decided advantage over that shown in Fig. 5 in that it does not necessitate the fixing of arbitrary limits for acceptance of a sand for use in concrete. This

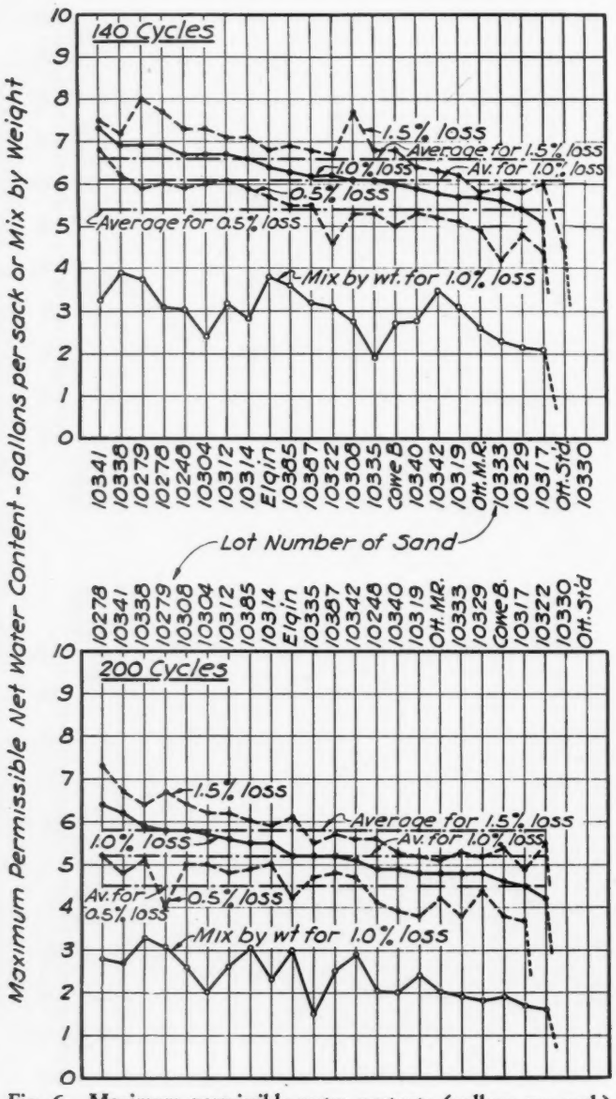

Maximum Permissible Net Water Content - gallons per sack or Mix by Weight
140 Cycles
1.5% loss
Average for 1.5% loss
1.0% loss
Av. for 1.0% loss
0.5% loss
Average for 0.5% loss
Mix by wt. for 1.0% loss
10341 10338 10279 10278 10246 10304 10312 10314 Elgin 10385 10387 10322 10308 10335 Cowe B 10340 10342 10319 Ott. M.R. 10333 10329 10317 Ott. Std 10330
Lot Number of Sand
10278 10341 10338 10279 10308 10304 10312 10385 10314 Elgin 10335 10387 10342 10246 10340 10319 Ott. MR. 10333 10329 Cowe B. 10317 10322 10330 Ott. Std
200 Cycles
1.5% loss
Average for 1.5% loss
1.0% loss
Av. for 1.0% loss
Av. for 0.5% loss
0.5% loss
Mix by wt for 1.0% loss

Fig. 6. Maximum permissible water contents (gallons per sack) for given loss in weight.

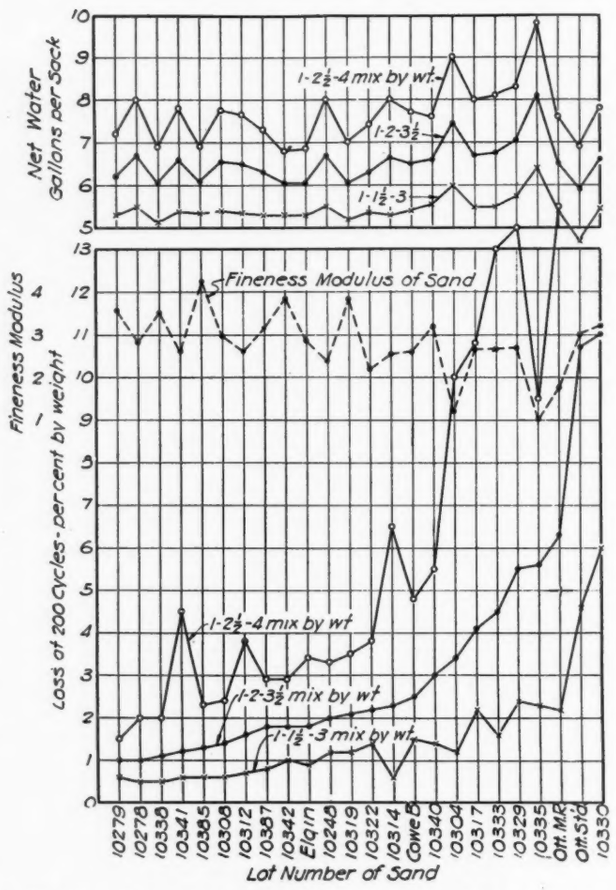

Net Water Gallons per Sack
1-2½-4 mix by wt.
1-2-3½
1-1½-3
Fineness Modulus
Fineness Modulus of Sand
Loss at 200 Cycles - percent by weight
1-2½-4 mix by wt
1-2-3½ mix by wt
1-1½-3 mix by wt
10279 10278 10338 10341 10385 10308 10312 10387 10342 Elgin 10246 10319 10322 10314 Cowe B 10340 10304 10317 10333 10329 10335 Ott. MR Ott. Std 10330
Lot Number of Sand

Fig. 7. Comparison of sands in concrete mixes of fixed proportions.

method of classification reveals the limitations of the different sands and denotes the conditions which each must meet in order to show a successful service record. For example, although sands 10319 and 10340 are below the average, they need not be rejected as non-usable, but their use should be restricted to mixtures in which the water-cement ratio (on the basis of 1-per cent. loss at 200 cycles) is not greater than about 5 gal. per sack.

The mixes by weight, corresponding to the maximum permissible water-cement ratios for 1-per cent. loss at both 140 and 200 cycles, show a gradual trend toward increase in richness as the water-cement ratios decrease. Therefore, for a given degree of permanence, there would be a considerable difference in the economy of the various sands, some requiring such rich mixes as to make their use uneconomical.

While it is believed that the classifications shown

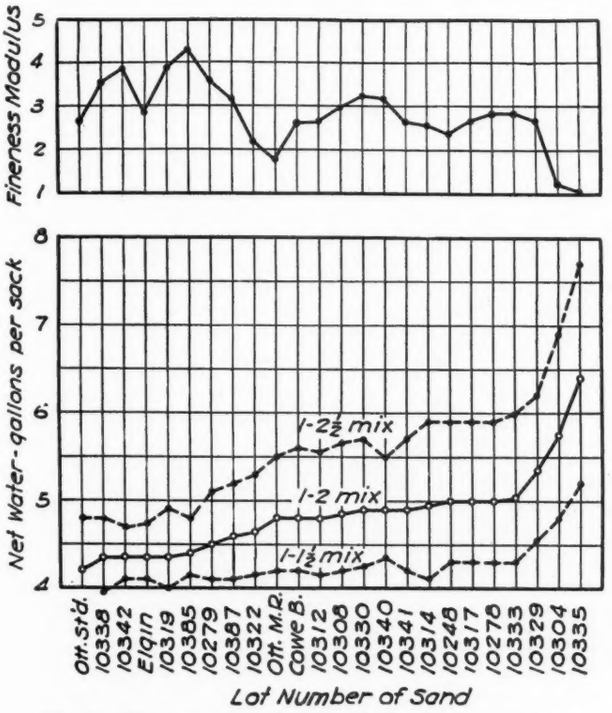


Fig. 8. Water requirements of mortar mixes of constant consistency. Data from curves in Fig. 2.

in Figs. 5 and 6 are in general fairly accurate, neither should be taken as absolutely exact, and fine distinctions between the various sands should not be drawn, for the influence of certain other factors as the porosity of the various mortars and the surface characteristics of the sand particles is not known. A classification entirely independent of weight measurements was made by arranging the 7-gal. cubes in order of failure as judged by their visual appearance at 140 cycles. This classification was not greatly different from that made on the basis of the weight measurements. The differences in appearance between the extremes were quite easily observed, but approximately two-thirds of the samples were so nearly alike as to make their classification by visual examination very difficult at this stage of the tests.

Concrete Mixes of Fixed Proportions.—It is of interest to compare the probable behavior of the various sands when used in concrete mixes of fixed proportions (1-1½-3, 1-2-3½, and 1-2½-4 by weight) and of uniform consistency. Such a comparison is made in Fig. 7, where the sands are arranged on the basis of the losses in weight at 200 cycles. These losses are for the mortars which would result if the sands were used in concrete mixes of the proportions indicated and with water-cement ratios required to produce about the same consistency. These water-cement ratios were obtained in the following manner. The water-cement ratios required by each sand in each of three mortar mixes (1-1½, 1-2 and 1-2½ by weight) for a uniform consistency were taken from the curves in Fig. 2. These are plotted in Fig. 8, where it will be noted that, omitting the two extremely fine sands (10304 and 10335), the 1-1½ mortar mixes require on the average about 4¼ gal. of water per sack. In the case of the 1-2 mixes, the water requirement varies consistently from 4¼ to 5¼ gal., and for the 1-2½ mixes from 4¾ to 6¼ gal. These water ratios are all on the basis of equal flow. As might be expected, the two fine sands require more water to produce the desired consistency than any of the others. The water ratios obtained for each mortar mix in Fig. 8 were then increased by amounts which, on the basis of data from other tests, were judged to be adequate to compensate for the addition of the coarse aggregate and to produce approximately the same consistency in the three concrete mixes shown in Fig. 7. These amounts were:

Mix by Weight	*Gallon per Sack Added*
1-1½-3	1.2
1-2-3½	1.7
1-2½-4	2.1

The resulting water-cement ratios for each of the sands when used in the fixed concrete proportions are plotted at the top of Fig. 7. They will be seen to be in line with those used in pavement construction where the mixes are comparable.

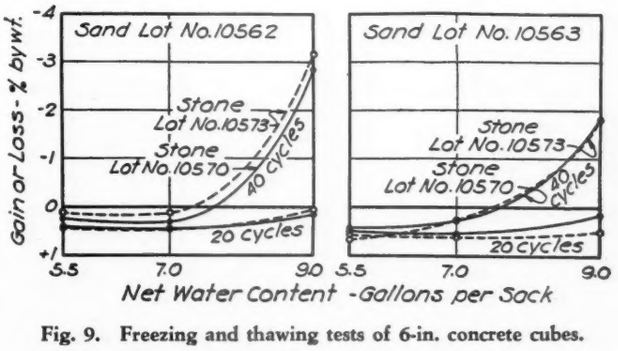

Sand Lot No. 10562
Sand Lot No. 10563
Stone Lot No. 10573
Stone Lot No. 10570
40 cycles
20 cycles
Gain or Loss - % by wt.
Net Water Content - Gallons per Sack

Fig. 9. Freezing and thawing tests of 6-in. concrete cubes.

It will be noted that the arrangement of the sands is entirely different in Fig. 7 from that in Fig. 8, where they are classified on the basis of their water requirements in mortar mixes. An outstanding example is standard Ottawa sand, which is at the extreme left in Fig. 8, by reason of its low water requirement in mortar. In Fig. 7 it is in the next to

(*Continued on page 46*)

Panoramic view of Dixie Lime Products Co. plants.

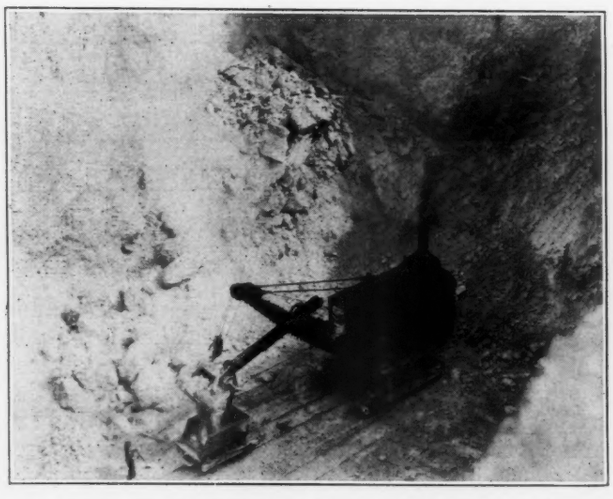
Lime Plants Produce Highway Materials to Balance Seasonal Demand

Quarrying Operations Follow Irregular Drift of High-Calcium Deposit of Rock

USING lime rock, or shell rock as it is sometimes called, as a raw material, the Dixie Lime Products Co., Kendrick, Fla., produces two types of construction materials, each of which serves a widely different market. With two complete plants, this company produces crushed lime rock for road materials and hydrated lime as well as lump lime. This diversion of products from a common source tends to stabilize operations and helps to maintain continuous employment of a regular crew of men, in spite of the fact that the market for each material is somewhat seasonal.

The Dixie Lime Products Co. is a well-known Florida concern, having been in business for a number of years. Interconnected with it is the Commercial Lime Co., another well-known Florida firm, whose list of officers is that of the Dixie company. W. M. Palmer is president of the Dixie Lime Products Co. and J. H. Williams is secretary and general manager.

Because of the high specification limits on the quality of lime rock—requiring it to contain no less than 97 per cent. C_aCO_3—pit operations are necessarily governed by the character of the deposit. Occasionally in a deposit of high-quality lime rock, an area of rock of somewhat lower calcium-carbonate content is encountered, so that the recovery operation must work at the side or around it. In the Dixie company pit, an excellent deposit occurs at a width of 150 ft. but not in a straight line. While the width of the cut remains quite constant, the curvature of the tracks, caused by the meandering of the operations in avoiding undesirable material, is considerable. The face of the pit maintains an average height of 65 ft. The deposit is stripped by means of an Erie ¾-cu.yd. shovel or with a dragline attachment used on the same machine. A number of Ford trucks haul the waste earth to a near dump. After machine stripping, the exposed lime-rock surface is carefully cleaned of clay and dirt



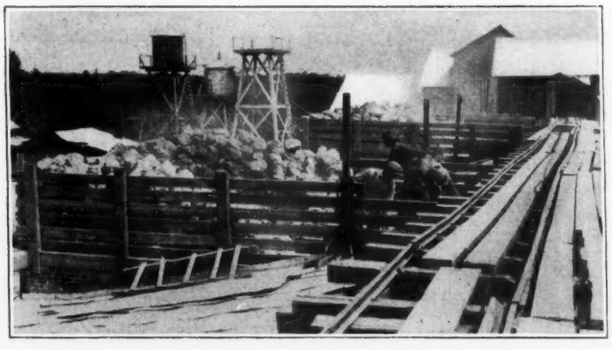
Loading an incline car for the lime-rock crushing plant.

Air-separation mill in center, sacking machine at right.

Operations in the Dixie Lime Products Co. lime-rock quarry.

pockets by hand. Six-inch blast holes are drilled by a Keystone drill-rig on centers determined by the location of the shot and the type of rock immediately needed, whether lime rock for road material or lime spalls for the kilns. A 30-per cent. nitroglycerine dynamite is used for the blasting of this material.

Blasted lime rock for the lime-rock crushing plant is loaded into Ocala Iron Works 3-cu.yd. front-dump pit cars by a Marion 1¾-cu.yd. shovel.

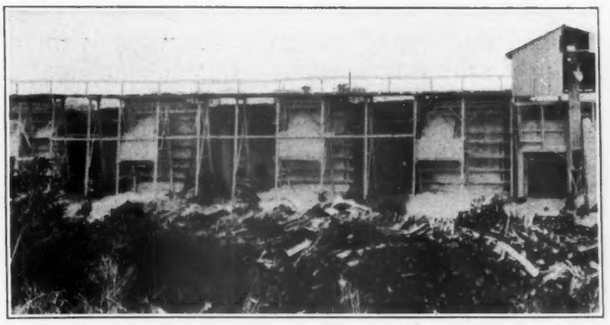


The tops of the kilns. Note spall-storage spaces.

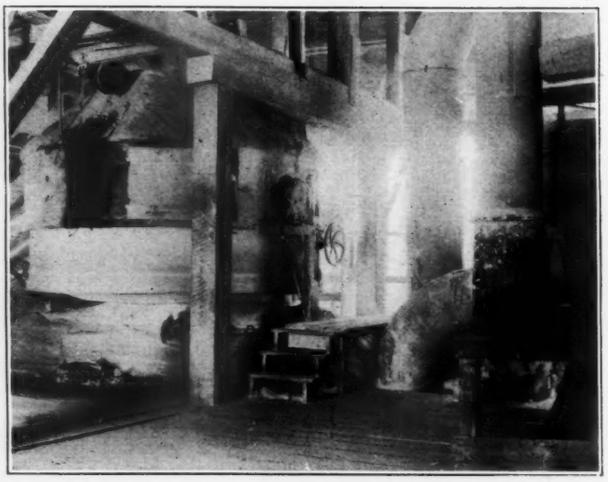
There are two pit cars in use, each on a separate track and individually drawn to the crusher hopper by Ocala Iron Works friction hoists. The approach from the pit floor to the plant consists of a double-track incline mounted on wooden bents. The cars return from the crusher-hopper platform to the loading shovel by gravity; by alternate operation of the two cars, little time is lost at either end of the system. To prevent the pit car wire ropes from lashing back and forth in the long pit, steel posts are erected at intervals along the tracks to serve as guides.

The preparation of lime rock for road-construction material is relatively simple, being merely the crushing of it to 2½ in. and under. This calls for, usually, a single crusher mounted over a side-track, the crushed material falling directly in open-top cars beneath. At the Dixie company plant an Ocala Iron Works 24-in. by 60-in. roll-crusher is employed. This type is commonly used in the lime-rock industry because of the softness of the material which tends to clog and pack in some machines. For motive power a Fairbanks-Morse 120-hp. Diesel engine is employed. Power is transmitted to the crusher and hoists through a line-shaft drive. The normal daily output of the lime-rock plant is eighteen 60-ton car-loads.

Spalls for the lime kilns are selected by hand in the pit and loaded into a White truck, which operates entirely on the pit floor, dumping its load at the foot of the lime-kiln incline. Here the incline car is lowered into a small pit over which the truck dumps directly into the car. The car is then drawn up the incline to a horizontal track over the kilns. Surrounding the top of each kiln is enough space for a considerable amount of spalls, thus providing a reserve supply. There are four kilns, three of which



View of the kilns, wood for burning piled up in foreground.



The hydrator on the left, air-separation fan on right.

are built of masonry construction and one of concrete. They are all 18 ft. square by 20 ft. in height with inside diameters of 6 ft. 6 in. With wood burning these kilns have a daily output of 5 tons each or a total of 20 tons. The kilns are drawn by hand.

Hydrated lime is produced in a modern plant adjoining the kilns. Lump lime is brought to the plant in wheelbarrows and dumped directly into an Ocala Iron Works 18-in. by 24-in. corrugated-roll crusher. After reduction to hydrator size, the lime is elevated to a steel-lined bin over a Clyde No. 1 hydrator which is located on the second floor of the building. After hydration, the lime is sent directly to a Raymond air-separation mill, which produces a 325-mesh hydrated lime. A Bates 4-tube packing-machine packs the finished material into multi-wall bags for shipment. Lump lime is shipped in steel drums and in waterproof asphalt-lined jute sacks.

Power for the hydrating plant is furnished by a Fairbanks-Morse Diesel engine of the same size as used in the lime-rock plant. The warm-water discharge from the cooling system of the engine is utilized in the Clyde hydrator.

Durability of Aggregates

(*Continued from page 43*)

the last position at the extreme right because of its high loss in mortar at 200 cycles of freezing and thawing. In the latter figure the sands are arranged on the basis of losses in weight upon freezing and thawing of mortar cubes made with the water-cement ratios existing in the concrete. In this comparison it is assumed that the mortar of the concrete will, upon exposure to freezing and thawing, exhibit the same relative degree of resistance as that shown by mortar cubes of similar water-cement ratio as illustrated in Fig. 3. While it is recognized that the mortar in concrete may not fail in quite the same manner as did the mortar cubes, the method of comparison is a logical one and serves to bring out the potential concrete-making properties of the various sands from the standpoint of durability.

It is most significant that the order of arrangement of the sands in Fig. 7 is not greatly different from that in Fig. 5, with the important exception that both the extremely fine sands 10304 and 10335 occupy positions at the right of the diagram among the shaly sands (10317, 10329, 10333 and 10340), stone screenings (10330), standard Ottawa, and run-of-mine Ottawa sand. These results show that some of the structurally-sound sands, because of their fineness, have such high water requirements that they would not be expected to make durable concrete if used in the usual fixed proportions. On the other hand, because of the structural weakness of many of the particles in some of the fairly well-graded sands, the concrete produced would be lacking in permanence. Harsh mixtures produced by improper gradings are likely to have low resistance to freezing because of the presence of air and water pockets.

Freezing and Thawing Tests of Concrete.—Each of twelve coarse aggregates, similarly graded from ¼ to 1½ in., were used in combination with two different sands in concretes having water contents of 5½, 7 and 9 gal. per sack. The concrete was molded into 6-in. cubes which, after 14 days of moist curing and 14 days in air, were soaked in water for 72 hr. and then subjected to freezing and thawing. Three cubes were made for each condition of test. They were submerged in water during freezing in covered metal containers slightly larger than the cubes themselves. This procedure was somewhat different from that employed with the mortar cubes, which, it will be recalled, stood in about ½ in. of water when subjected to freezing.

Examinations of the concrete cubes were made at frequent intervals, but as only 40 cycles have been attained to date, the tests are not far enough advanced to bring out any decided differences in the performance of the various aggregates. Results for two of the coarse aggregates in combination with each of the two sands are plotted in Fig. 9. The slight gain in weight indicated for some of the cubes is believed, due to normal gain, to be expected from continued hydration of the cement and the absorption of water by the embedded aggregates. This is eventually counteracted when the cubes begin to disintegrate under freezing action.

On the basis of direct soundness tests, sand 10562 was judged to be somewhat better than sand 10563, and stone 10573 better than stone 10570. However, at this stage of the concrete tests, no decided differences in results have been observed where the water-cement ratios of the cubes are the same. It will be noted that, in both diagrams of Fig. 9, the 9-gal. cubes are beginning to show appreciable losses in weight, which fact again emphasized the harmful effect of this relatively high water content on the resistance of mortars and concretes to freezing.

Accident Hazards Present in Shipping, Packing and Storing Cement*

By R. H. MacFETRIDGE and STEWART J. OWEN

ALTHOUGH the storing, packing and shipping departments of the average cement plant are usually not looked upon as hazardous places, in comparison with the quarry, coal-grinding, and other departments, nevertheless, they have been the scenes of many accidents. Careful consideration of these departments will show that they have contributed a number of accidents which have resulted in death or permanent injury. Therefore, they are worthy of careful consideration from an accident prevention standpoint. In these departments, the screw conveyor and sliding materials have always been among the leading hazards.

Screw Conveyors

The greatest danger in the operation of spiral screw conveyors is that of workmen getting their hands or feet caught in the conveyor. When the conveyor becomes clogged, workmen sometimes endeavor to dislodge the material without first shutting off the power. In so doing, they not only take a chance of catching their hands or feet in the conveyor, but other employees—not perceiving the conveyor lids have been removed in order to release the clogged condition—may step into the conveyor, resulting in serious injury.

Never, under any conditions, should an attempt be made to loosen material in a screw-conveyor trough, or make any repairs, without first shutting off the power and locking the motor switches, as well as hanging a danger tag—reading, "Man working on conveyor"—on the starting switch.

A safe practice is to provide with a safety lock those men who are authorized to make repairs on screw conveyors, or motors or to clear out material which has blocked the screw. When it is necessary for any man to work on a screw conveyor, he should fasten the switch with his lock. If an operating man, an electrician, and a mechanic are working on the unit at the same time, each should have his own lock on the switch.

As each man completes his work, he removes his lock, and when the last man is through a careful inspection should be made to see that everybody is in the clear and that the covers, guards, etc., have been replaced before operations are resumed.

A pin fastened to a chain can be attached to the switch box. This pin can have enough holes drilled in it to take care of the locks; when the switch is to be locked the pin can be slipped through the staple on the switch box and the lock inserted in one of the drilled holes and locked.

A method used by some plants to insure against accidental starting of a screw conveyor is to interlock all the screw-conveyor openings, either mechanically or electrically, with the control unit. Whenever a cover is removed the power is automatically shut off.

All conveyor troughs should be completely covered. The covers should be made in removable sections for the purpose of inspection and convenience in dislodging choked material.

The design of the conveyor trough should be such that, where possible, the trough is not submerged below the floor level, or located where employees are compelled to walk over the conveyor. The best practice is to set the conveyor trough on the floor, or support it so high above the floor that employees can not step into it. The conveyor, when submerged, should be equipped with a grating covering its entire length and permanently anchored, so that when the lids are removed it will still be impossible for anyone to come in contact with the conveyor proper; in case lids are removed for clean-up purposes, the material can be thrown into the conveyor through the grating without any chance of an employee coming in contact with the screw. Covers should be placed over the grating so as to make the conveyor dust-tight.

Recent installations, where pumps and transport lines are used in conveying cement, have eliminated the screw-conveyor hazard. However, the same precautions with respect to locking motor switches and displaying danger tags should be followed in making repairs to the pump, or to the transport line serving it. Careful attention should also be given to small leaks in the line to avoid cement being blown into the worker's eyes.

Cement Slides

In the older plants cement is stored in bins and open-type stock houses, with walk-ways running along the side of the bins. Often the cement is allowed to pile up in the bin until it runs over on the walk-way. Employees inspecting the bins have been killed, due to being thrown into the cement and smothered as a result of the walk-way collapsing. Walk-ways should be so designed and located that the cement can not pile on them.

The design of the older type bins is such that after a small quantity of the cement has flowed into the conveyor, the balance must be removed by hand or by feeding it into a cross conveyor leading to the main conveyor. When the cement is thus distributed to cause a flow, the workman must be on his guard continually to avoid being caught by an abrupt and heavy slide of material, and he should be provided with a safety belt equipped with a rope snubbed to the top of the bin. The employee working under these conditions is often limited as to space, and the lighting conditions are often inade-

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quate, due to dust arising from the sliding material. Therefore, another employee should work with this man when breaking down the pile of material, so as to be on the lookout for quick slides. Where possible, the workman should stand on the walk-way above the bin and use a light rod or an air lance to break down the material until it reaches a safe angle of repose.

Where the design of the stock house will permit, a safe footing for bin men may be obtained by means of safety scaffolds with a windlass ratchet arrangement by which the men may raise or lower themselves. If a slide should occur when using such equipment the men can easily pull themselves out of it.

Ladders of standard construction should be provided where necessary for safe access to bins and silos. Cross-grained lumber should not be used for ladder material. The habit of laying planks across bins on which to stand while working should be prohibited, as planks have broken or slipped, throwing the employees into the cement and resulting in injury or suffocation.

Stock-houses having tunnels in which conveyors are located are usually fed by spouts spaced at short intervals. Under such conditions the cement flows into the conveyor, but it becomes necessary for the men to enter the bin to move the cement by hand until the contents have been so reduced that there is plenty of room, light and ventilation to remove the small piles of cement which have not flowed freely to the conveyor.

When freshly-ground cement is being worked it often moves quickly and in heavy slides upon the least disturbance. Slides have resulted from the jar caused by blasting operations in nearby quarries, or from vibration due to the movement of trains on nearby tracks. Therefore, when removing cement from open-type bins, in case the piles are being broken down by hand, it is necessary to keep the workmen out of the bins during operations which may cause a slide of cement.

Care should be taken to furnish a long rod and a long-handled hoe to start the cement. Ropes should be used where conditions permit. Men should be instructed as to the danger of under-cutting the cement to induce slides, emphasis being laid upon the fact that hoeing, or the use of a rod, should be done from the top of the pile, and the cement worked on a terrace plan. Compressed air can also be used to good advantage in starting a flow of cement from a bin. Care should be taken, however, that the air is free from moisture.

In the modern-type storages of silo construction, most of the hazards due to the open-bin or stock-house type of storage have been removed. Nevertheless, care should be taken that all manhole openings in the tops of the silos are equipped with permanent gratings and dust-tight covers. Care should also be taken that the gratings are permanently anchored and sealed. The foreman in charge should report any occasion requiring the breaking of the seal and his reason for securing a new seal.

In case it is necessary to clean out silos, compressed air can be used with the help of a long pipe to break down any arches or piles of cement which may hang to the silo walls. When loosening cement with an air lance men should be cautioned to push the lance into the cement before opening the air cock; and the air cock must be closed before withdrawing the lance. If these precautions are observed there is little likelihood of a man getting a face full of cement. Sometimes it is necessary for men to enter the silos with a long bar to break down the lumps on the side walls. In this case safety belts should be worn. The men should also be provided with and required to wear respirators and substantial, dust-proof goggles.

Packing and Loading Hazards

Packing-machine main-drive belts, couplings, gears, and the eccentrics, belts and pulleys on bin-feeder drives should be guarded in a substantial manner. Construction of such guards is standard practice in any well guarded plant. Their use will avoid the possibility of the employee being injured because of fingers or clothing caught in the moving

Packing machine with dust shield in raised position.

Packing machine with dust shield in operating position.

parts of the machines. Packing-machine feed spouts that have become sharp by the abrasive action of the cement should be replaced.

Many accidents in the packing room and stock houses are caused by cement spurting into the face and eyes of the packing-machine operators, due to a bag bursting, or to a small hole in it. This type of hazard can be eliminated, partly by the proper location of the seat on which the machine operator sits, and entirely by compelling operators to wear goggles that are suitable for this particular kind of work. One firm has eliminated the necessity for goggles at packing machines by the installation of a patented plate-glass shield in front of the machine.

There has been considerable discussion and difference of opinion as to the advantage gained by the packing-machine operator in wearing goggles. Claims have been advanced that during hot weather the combination of perspiration and a small amount of cement dust makes the goggles ineffective. However, the fact that goggles are being worn successfully by many packing-machine operators proves that they are entirely feasible; it is only necessary that the rule requiring their use shall be strictly enforced by the foreman.

A drinking fountain is a natural and easy means for washing out the eye when cement has spurted into it. Most cement plants have emergency hospitals supplied with the necessary equipment for treatment of such injuries, and all injured employees should be required to report at once to such hospitals for medical treatment.

Cement Dermatitis

Considerable time is lost because of disabilities due to cement dermatitis. Since these disabilities do not excite the same attention as injuries of a more severe character they are not always classified as accidents and complete reports are not received as they should be.

Aetna Life Insurance Company's Health Article No. 153 contains the following information on cement dermatitis and its prevention:

"Workers engaged in handling Portland cement, both in cement mills and on construction and other work in which cement is used, sometimes suffer from skin burns and eruptions known as "cement dermatitis." This condition is caused by the irritating effect of the lime which the cement contains, by the clogging of the pores of the skin by hardened particles of cement, and by the chafing and cutting action of the hard grains against the skin. The lime also tends to remove the protective oil coating from the skin, making it dry and likely to crack. Workers seem to suffer more from this eruption in the summer time, probably because sweating increases the action of the cement on the skin.

"Cement dermatitis starts as an itching rash somewhat like eczema, and the sores often become swollen and infected. Persons with tender skin are more subject to it than those whose skin has become hardened. The eruption usually occurs on the hands and arms, although it may appear on any part of the body.

"The best method of preventing cement dermatitis is frequent bathing. The hands and forearms particularly should be washed thoroughly and often with plenty of warm water and soap, to remove the cement completely from the pores and surface of the skin. Wash rooms with hot showers should be provided in cement mills, and ample washing facilities should be made available on outside jobs.

"It is also advisable to cover the hands and arms with a coating of a suitable ointment to replace the oil in the skin and keep the skin from cracking. The following ointment is suggested:

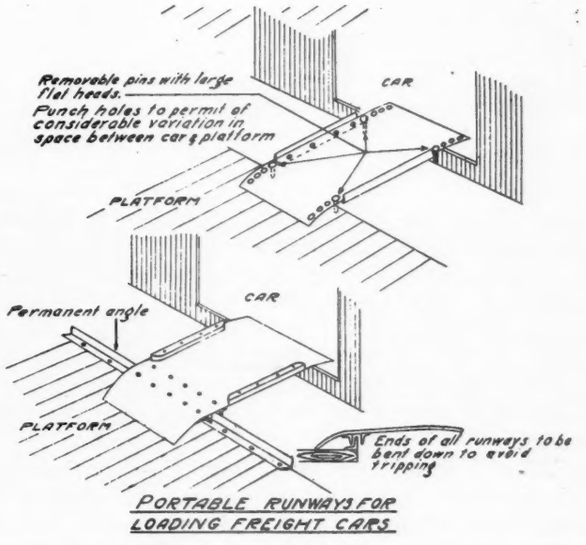
Petrolatum (vaseline) .....3 parts
Lanoline .....1 part

"Protective clothing is a very effective precaution. Gloves of rubber or strong, closely-woven fabric should be worn wherever possible. Workers in wet concrete should be equipped with rubber boots. Outer clothing should be of closely-woven fabric and should fit tightly at the wrists and ankles. Clothing should be kept dry and should be washed frequently.

"Men who are unusually susceptible to cement dermatitis should not be assigned to cement work. The hands of all cement workers should be watched for signs of eruption, and first-aid treatment should be given early to avoid infection and spreading. Men not used to handling cement should be particularly careful; older employees gradually become immune to cement dermatitis, but new workers contract it very readily. Workers should avoid coming into contact with wet concrete.

"Summarizing, prevention of this condition consists in bathing frequently, greasing the hands and arms with a suitable ointment, and wearing gloves, long sleeves and rubber boots. Workers should report for first-aid treatment for even slight evidences of eruption."

Whether cement in bags is discharged directly from the packing machines into the car, or on a conveyor belt and thence to the car, the trucking of the


Removable pins with large flat heads.
Punch holes to permit of considerable variation in space between car & platform
CAR
PLATFORM
CAR
Permanent angle
PLATFORM
Ends of all runways to be bent down to avoid tripping
PORTABLE RUNWAYS FOR LOADING FREIGHT CARS

Two types of portable runways for loading and unloading freight from box cars.

cement into position in the car is essential. Trucking has its hazards, such as men striking their hands against the side or end of the car, slipping on the floor, and an occasional upset when passing over poorly-constructed or improperly-anchored runways.

Careful inspection should be made to see that the trucks are in good condition, that they can be operated with the least amount of effort, and the load balanced properly. The handles should be kept in smooth condition. The trucks used by one cement company have the wheels mounted inside the rocker plate. With such a truck it is easier to turn the load quickly, and at the same time the wheels are so located under the load that they can not run over a bystander's foot. Such a truck not only protects the user but also increases his efficiency.

If it is necessary to use a gang plank from the platform to the car, care should be taken that the plank is in sound condition, and that it is equipped with clips so that it can be anchored and will not shift—thus causing the truck with its contents (and very often the employees operating the truck) to fall between the cars and the platform, resulting in injury. Metal "planks" are often used for this work. They should be secured in place whether or not there is a difference in the level between the car floor and the loading platform. This can often be done by the use of cleats of angle iron attached to the under side of these walkways or by drop

Trucking sacked cement to cars. Note guards on truck wheels to prevent running over a bystander's foot.

bolts. Slipping on these walkways can be reduced by using perforated plates which will drain readily.

A practical method of loading sacks in a box car is to use a belt conveyor to the car door and discharge onto a warehouse truck, 10 sacks high. One man can transport this load into either end of the car and discharge the load in the form of a pile 10 sacks high without any rehandling of the individual sacks.

When loading cement in bulk a measuring bin which holds the required amount of cement to load the car should be provided, or a trestle for the men to stand on should be used. Either of these methods will make it unnecessary for workmen to enter the car to level down the contents to the volume line chalked on the side of the car. When men are required to go into the car and level down the cement, burns on the feet and legs are often the result.

Men are subject to strain when they are turning up sacks in order to obtain higher tiers. This is true in loading cars of 300-bbl. capacity where bags must be piled twelve high in every tier, which is four bags higher than can be thrown by a buggy. In such cases two men should pile up these bags, one at each end of the bag, and both men throwing simultaneously.

At some plants the railroads that furnish the empty cars for cement loading, clean them before delivering them to the plant. The packing-house foreman inspects the delivered cars and if they have not been properly cleaned they are returned to the railroad.

If the cars are cleaned by cement-plant employees this cleaning should be done on a spur track in a suitable location, so that the cars may be cleaned and the rubbish burned before they arrive at the packing house for loading. This will prevent pieces of wood containing nails, broken glass, crockery, and other rubbish from being swept out of the car along the loading places, where they may be stepped upon with perhaps serious injury to packing-house employees or members of the switching crew.

Horse-play among all employees should be absolutely prohibited.

In preparing sacks for the packing department, care should be exercised to examine them carefully for proper strength of fabric and the elimination of small holes, so as to prevent sacks from bursting at the packing machines and causing burns and eye injuries due to hot cement.

In storing sacks that have been cleaned, care should be taken that the piles are erected in a self-supporting manner, cross-stacked and tied so that when a part of the sacks are removed the pile will not fall on the workmen. The piles should be arranged with gangways between, and if over 10 feet high should be drawn in as they go up.

The same code of rules for the operation of other machines should apply to the operation of the sack cleaner; the machine must be brought to a stop before workmen enter the wheel to remove sacks, and the motor switch should be locked while making repairs to the cleaner. Sometimes the bag cleaner is provided with a pin, hook, or other locking device that will prevent its operation while men are inside the machine. Some plants use a red light at the cleaner starter. When the cleaner is stopped the red light is on until the last man is out of the cleaner and the doors closed. The man who locks the doors turns off the light as a signal to start. The same man should always stop and start the cleaner.

Care should be taken when removing wires with which bundles of empty cement sacks are tied, as spring wire often is used, and when this is cut with the pliers the loose ends fly. The wire should be held in one hand and snipped at the lower part of

An orderly bag-sorting room.

the bale so that the wire can not spring toward the workman. Recently at least one case occurred where the end of the wire struck a workman in the eye, causing him to lose it. The wearing of suitable goggles will prevent accidents of this kind.

Car Movements

The shifting of cars at packing houses has its dangers. Failure to give the workmen proper notice before the shift is started, the failure of men to heed the warnings, cars breaking loose, men running in front of cars, and jumping on them, are responsible for many accidents.

When cars are spotted with a switch engine the switchmen should have written instructions not to bump into a string of cars at the pack house until the car checker and others have been warned and it is known this warning is understood. Suitable penalties should be imposed for failure to give these warnings.

A proper signal, such as a light, should be provided as a means of informing railroad men when cars may be sent in or shifted on the loading tracks. This signal should be operated by the packing house foreman. If a light is used, shifting should be done on the loading track only while the light is on. Danger signals, such as flags, should be displayed at the front and rear of cars which are being loaded and unloaded as a notice to trainmen that men are working in the cars. In some plants a siren is blown several minutes before the cars are moved to or from the loading platforms, thus giving every one ample time to get in the clear.

At most plants, the tracks adjoining the packing house are on a grade, and care must be taken to set the brakes and chock the cars so they will not move and result in injury to workmen who may be trucking cement into the cars, cleaning cars, or preparing them for shipment. Derailers have been installed at some plants, and the engine crew must give the packing house full notice of a shift about to be made before the cars go past the derailer. Some plants are also equipped with a car puller, which involves the hazard of workmen coming in contact with the taut cable with which the car is being pulled. Care must be exercised to avoid accidents from this source, by the use of warning signs, the education of employees, and regular inspection of the cable.

Where the car-loading tracks run away from the packing platform at an incline, it is well also to make it a rule that each car be ridden down to the string ahead by a man, to be sure that no one fails to see this slow-moving car and suffers injury. By observing this rule the car will always be under control.

Phosphate-Rock Production Reaches Highest Point in Past Decade

WITH occasional exceptions, the marketed production of phosphate rock mined in the United States has been steadily increasing. In 1930 the sales of this commodity reached the highest point in the history of the industry during the past decade.

According to a statement by the U. S. Bureau of Mines, based on figures compiled from individual reports of the producers, the total quantity of phosphate rock sold or used in the United States in 1930 was 3,926,392 long tons, valued at $13,996,830. In comparison with 1929, these figures represent increases of 4.4 per cent. in quantity and 6.4 per cent. in value. The average value per ton in 1930 was $3.98, as compared with $4.02 in 1929.

State	Production (*long tons*)	Shipments		
		Quantity (*long tons*)	Value	
			Total	Average
Florida:				
1930	3,261,539	3,248,071	10,790,305	3.32
1929	3,125,941	3,088,298	9,901,074	3.21
Idaho:				
1930	64,129	59,932	234,543	3.91
1929	39,022	35,899	141,931	3.95
Montana:				
1930	6,005	6,005	27,457	4.57
1929	40	40	400	10.00
Tennessee:				
1930	618,341	611,045	2,938,525	4.81
1929	653,265	633,939	3,079,104	4.86
Wyoming:				
1930	1,339	1,339	6,000	4.48
1929	3,572	2,679	12,750	4.76
Grand Total 1930	3,951,353	3,926,392	13,996,830	3.56
1929	3,821,840	3,760,855	13,153,259	3.50

Florida continued to be the leading phosphate-rock-producing state. Total shipments amounted to 82.7 per cent. of the total phosphate rock sold or used by producers in the United States in 1930, as compared with 82.1 per cent. in 1929. Shipments were the greatest ever recorded for the state, with the exception of 1920, when they were exceeded by 121,313 tons, or 3.6 per cent. In comparison with 1929, the figures indicate increases in quantity and value of 5.2 and 9.0 per cent., respectively. The total amount of phosphate rock exported from Florida in 1930 (1,173,861 long tons), constituted 36.1 per cent. of the total marketed production of this state, and indicated an increase of 5.7 per cent. over 1929. The total marketed production for consumption in the United States (2,074,210 long tons), increased 4.9 per cent. in quantity, as compared with 1929. Of the total marketed production for domes-

tic consumption, 91.1 per cent. was used in the manufacture of superphosphates, compared with 88.9 per cent. used for this purpose in 1929. The total average selling value a long ton in 1930 was $3.32; in 1929 the corresponding value was $3.21 per ton. In 1930 three kinds of phosphate rock were commercially mined in Florida—hard rock, soft rock, and land pebble.

The total marketed production of hard rock in Florida in 1930 was mined in Citrus County by two producers. It was sold, however, by four shippers, two of whom sold from stocks on hand. Of the total (81,753 long tons), 63,802 tons—or 78.0 per cent.—was exported, compared with 88.9 per cent. in 1929. The remainder was sold for consumption in the United States.

Although there was an increase of 12.9 per cent. in quantity and 93.6 per cent. in value of hard rock shipments in 1930 as compared with 1929, this fact should not be construed as indicating that a turning point has been reached and that there was an increase in demand for this rock. On the contrary, conditions in the hard rock field were virtually unchanged from 1929, when sales reached a new low since the World War. The two producers of hard rock in Florida in 1930, J. Buttgenbach & Co., Dunnellon, and the Mutual Mining Co., Savannah, Ga., each reported decreased sales as compared with 1929. The total production of these two operators was exported. The increase in total sales, therefore, was contributed by those who sold from stocks. The increase in average value per ton is partly attributed to the fact that in 1930 the total value represents, as far as possible, dry rock, f.o.b. mine shipping point, whereas in 1929 a portion of the production was valued on a wet rock basis at the mines.

Florida hard-rock producers are still feeling the competition with African phosphates imported into Europe, the production reported from Mococco (French) and Tunisia in 1930 indicating substantial increases over 1929.

Soft rock, from Polk County, was shipped by the Lakeland Phosphate & Fertilizer Co., Bartow. The product, used chiefly as a fertilizer filler, was consumed in the United States.

The commercial production of land-pebble rock in 1930 was the largest ever reported, and represented increases of 4.99 per cent. in total quantity and 6.64 per cent. in total value over 1929. The production was mined in Hillsborough and Polk Counties by 7 producers, the same number as in 1929. The total quantity (including soft rock) constituted 97.5 per cent. of the total marketed production of the state in 1930, as compared with 97.7 per cent. in 1929. Approximately 65 per cent. of the land-pebble shipments in 1930 (2,056,259 long tons) was consumed in the United States and 35 per cent. (1,110,059 tons) was exported. These percentages were the same in 1929. The average value (f.o.b. mine shipping point) was $3.24 per ton; in 1929 the corresponding value was $3.19 per ton.

One of the outstanding developments in the phosphate-rock industry in Florida in 1930 was the introduction and application of the oil-flotation process by the International Agricultural Corp., New York, for the recovery of phosphate from material that was formerly wasted. The success of the experiments is apparently assured, as it is reported that concentrates of high grade are being produced at favorable costs.

During 1930 the Southern Phosphate Corp., Baltimore, Md., constructed a new drying plant of steel and concrete construction in the pebble district at Ridgewood, Fla., which has a wet-storage capacity of 60,000 tons and a drying capacity of about 30,000 tons.

Two types of phosphate rock were mined in Tennessee in 1930—brown rock and blue rock, over 90 per cent. of the marketed production being brown rock. Sales, which amounted to 611,045 long tons, valued at $2,938,525, showed a decrease of 3.6 per cent. in quantity and 5.1 per cent. in value, as compared with 1929. The figures also indicate that the total quantity sold represented 15.6 per cent. of the total marketed production of phosphate rock in the United States during the year, as compared with 16.9 per cent. in 1929 and 16.5 per cent. in 1928. In 1907, when the marketed production in Tennessee reached its highest point of 638,612 tons, the marketed production represented 28.2 per cent. of the total commercial production in the United States. The compilations also reveal that in 1930, 67.0 per cent. of the production was used in the manufacture of superphosphates, as compared with 71.5 per cent. in 1929.

The marketed production of phosphate rock in the Western states—Idaho, Montana, and Wyoming, increased 74.2 per cent. in quantity and 72.8 per cent. in value, as compared with 1929, due mainly to the advent of two new producers in this field, one each in Idaho and Montana.

In Idaho the Anaconda Copper Mining Co. operated, as usual, at Conda, Idaho. The product, treble superphosphate, was in former years sold chiefly to fertilizer manufacturers for use in producing high analysis mixed fertilizers. During the last three years it has been used with success for fertilizing sugar beets in Colorado, Utah, and Idaho.

The Solar Development Co., Ltd., Trail, B. C., a new operator, began operations at the Star mine, Paris, Idaho, in November, 1930. The production was shipped to Canada for the manufacture of superphosphates.

The marketed production of phosphate rock in Montana in 1930 increased many times in both quantity and value over 1929. Two new operators, Dissett Bros., Philipsburg, and the Montana Phosphate Co., Garrison, produced the total marketed production of Montana in 1930. Dissett Brothers operated the Red Hill mine, nearest post office Philipsburg, Granite County, and the Montana Phosphate Co. operated the Anderson mine, nearest post office Garrison, Powell County. The total output was shipped to Canada for the manufacture of superphosphates.

The total output from Wyoming in 1930 was produced by one operator, the Cokeville Phosphate Co., Cokeville. The entire production was consumed in the United States for direct application to the soil.

Effect of Time in Transit on the Strength of Ready-Mixed Concrete*

By PROF. WILLIS A. SLATER
Fritz Engineering Laboratory, Lehigh University

IN recent years the use of central-mixing concrete plants in concrete construction work has grown rapidly. It has been found that the problem of the central mixing plant which is most difficult of solution is that of transportation of the mixed concrete from the plant to the construction job. Much progress has been made, from transportation in open trucks, to the use of closed conveyors which do part of or all the mixing *en route*.

The machine which formed the basis of the tests herein described was manufactured by the Clinton Motors Corp., Reading, Pa. It, the Clinton concrete conveyor, consists of a closed cylindrical body without blades, mounted on a motor truck. In a test made at Fritz Engineering Laboratory of Lehigh University, one of these conveyors, having a rated capacity of 2 cu. yd., was charged with concrete mixed in the laboratory and transported for 2½ hr. on the streets of Bethlehem. Samples were taken of the concrete as it came from the mixers. About 7 min. after leaving the laboratory, and thereafter at successive intervals of about ½ hr. each, the conveyor returned to the laboratory for taking more samples. The samples were used for determining the properties of the concrete, as described later.

The purpose of the test was to determine, first, the relation between the strength of the concrete and the length of time that it was retained in the drum of the conveyor, while it was being transported from the central-mixing plant to the job, and, second, whether a drum without blades would maintain the homogeneity of the concrete during transportation in at least as good condition as that in which it was received from the mixer.

Every reasonable and feasible precaution was taken to control accurately the quantities of all the materials going into the conveyor, so as to afford a basis for comparing the composition determined by tests, with the proportions actually used. These precautions extended to allowing for the absorbed and surface moisture in the aggregates in weighing the mixing water. The general scope of the investigation was laid out with the advice of W. S. Painter, representing the manufacturer of the conveyor, and J. C. Pearson of the Lehigh Portland Cement Co., Allentown. Mr. Painter was present throughout the making of the concrete, charging of the conveyor, and the taking of the samples of concrete. The direction of the preparation for the tests, operations with the conveyor, and the carrying out of the tests of the concrete were entirely in the hands of the writer. Mr. Pearson and E. M. Brickett, also of the Lehigh Portland Cement Co., were present during the last afternoon of the operation of the concrete conveyor, that is, during Series D.

The weighing of all the material for the mixes was placed in charge of C. C. Keyser, and the making of the control cylinders in charge of G. W. Parkinson, both of the Fritz Engineering Laboratory staff. Professor W. M. Dunagan of Iowa State College, Ames, Ia., was employed by Lehigh University to take charge of the tests made to determine the composition of the freshly-mixed concrete.

The operations with the concrete conveyor took place on Dec. 29 and 31, 1930, in five separate runs designated hereafter as Series A, B, C, D and E, in the order named. Each of the first four series consisted of charging the conveyor with 2 cu. yd. of concrete, driving the conveyor around the streets for about 2½ hr. and taking samples at intervals as outlined elsewhere. Each of these four series occupied about 4 hr.

Series E differed from the rest in that the conveyor was driven around with its charge of concrete for only 1 hr. 15 min. instead of 2½ hr. and in that no samples were taken either for determining the composition of the concrete, or its strength. It was used principally for inspecting the appearance of the concrete in the drum, and during its discharge. An additional test was made in which, for comparison, samples of concrete were taken at intervals from a batch which was mixed in one of the Jaeger mixers used throughout the test.

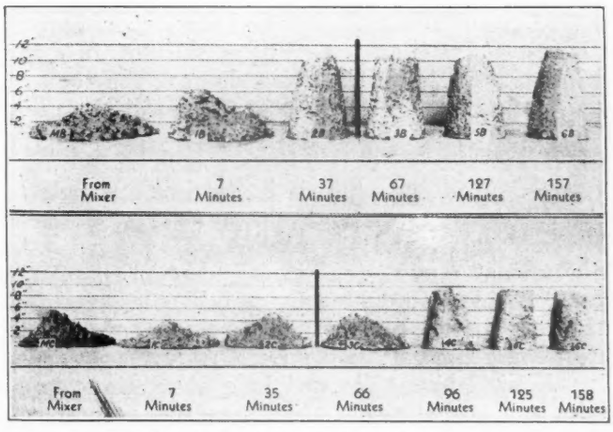


Fig. 1. B series above; C series below.

Description of Conveyor.—The Clinton Concrete Conveyor consists of a truck upon which is mounted a cylindrical drum container into which the concrete is placed through an opening in the surface of the cylinder, about midway of its length. This opening is provided with a door which is closed as soon as the charge has been received. A rubber

* Presented before the American Society for Testing Materials.

gasket, occupying a groove in the lip of the opening, furnished a means of sealing the door so tightly that no leakage was observed during the rotation of the drum.

The drum is entirely smooth on the interior and depends entirely upon friction of the concrete on the interior surface for any mixing action which may take place. The conveyor is not intended primarily as a mixer, but it is expected to provide

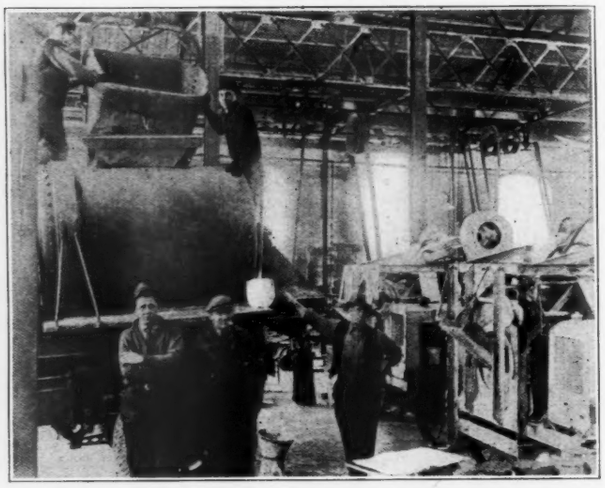


Fig. 2.

enough agitation to prevent segregation of the concrete during its transportation. During transportation the drum rotates slowly, that is, at about 8 r.p.m. The mechanism which rotates the drum is independent of that which drives the truck, so that the drum may be rotated independently of the movement of the truck.

The concrete was discharged through a door at the rear end of the drum. The rotation of the drum is stopped with the charging door at the top and the discharge door at the bottom. In discharging, the front end of the drum is lifted by a power hoist, which forms a part of the equipment of the conveyor, so that the drum is inclined at an angle of about 30 degrees. The discharge door at the rear is then opened and the concrete discharged. At the beginning of the charging operation there was a slight leakage of water due to lack of tightness of fit of the discharge door. The leakage appeared to come from the very bottom of the discharge opening. This leakage stopped in a short time, however, and no indication of leakage was seen thereafter until the next time that the conveyor was charged. It was estimated that the water lost in this manner from any charge did not exceed about a quart, that is, about one-third of one per cent. of the total amount of water in the charge.

Materials.—In order to ascertain whether the consistency of the concrete, at various times after mixing, or its strength bore any relation to the time of initial set of the cement, seven different cements purchased in the market were tested for time of initial set, and the two which showed the longest and shortest times of initial set were selected for the test. Two tests were made on each cement, and

TABLE I.—TIME OF SET OF CEMENTS.

Cement No.	Test No.	Time of Set		Cement No.	Test No.	Time of Set	
		Initial (*min.*)	Final (*min.*)			Initial (*min.*)	Final (*min.*)
1	1	201	350	5	1	190	365
	2	155	325		2	140	310
	Avg.	178	337		Avg.	165	337
2	1	193	341	6	1	188	333
	2	162	310		2	142	315
	Avg.	178	325		Avg.	165	324
3	1	196	357	7	1	157	342
	2	151	340		2	122	302
	Avg.	174	348		Avg.	140	322
4	1	172	358				
	2	160	322				
	Avg.	166	340				

the results are given in Table I. Here the cements are numbered in the reverse order of the average length of time required for the initial set. Cement No. 1 was used in Series A and C, and cement No. 7 in Series B and D. With cement No. 1, 1.6 per cent. was retained on the No. 100 sieve, when the cement mixed with sand was screened in water.

Sand.—The sand used came from Succusunna, N. J. It was well graded and appeared rather coarser than the concrete sand generally used in this part of the country. Its specific gravity was 2.68. Its weight, when rodded dry into a 0.1-cu. ft. measure, was 109.1 lb. per cu. ft., and the voids under this condition amounted to 35 per cent. It had a fineness modulus of 3.15. About 3 per cent. of it was retained on a No. 4 sieve and about 2.1 per cent. passed the No. 100 sieve.

Gravel.—The gravel contained about 50 per cent. of broken pieces formed by passing the larger pieces through a crusher. All passed a 1¼-in. sieve. The specific gravity of the gravel was 2.64. Its weight, when rodded dry into a 0.1 cu. ft. measure, was 97.9 lb. per cu. ft., the average for three tests. The voids in this condition amounted to 41 per cent.

Conduct of Test.—Two small Jaeger mixers were used for mixing the concrete. Eight batches, four in each mixer, were used for each charge of 2-cu. yd. This kept well within the manufacturer's rated capacity of the mixers. The cement and aggregates were used in the proportions 1:2:4 when stated in terms of volumes of dry material rodded into a standard measuring vessel, or 1:2.33:4.15 when stated by weight. Seven gallons of water per bag of cement was used, and the absorbed and surface

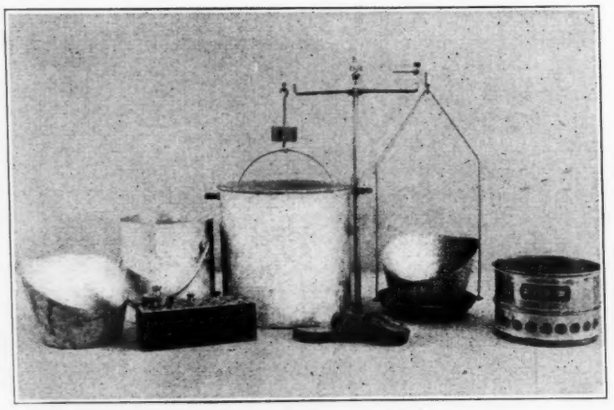


Fig. 3.

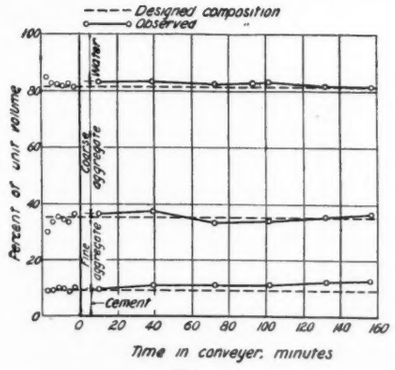


Fig. 4.

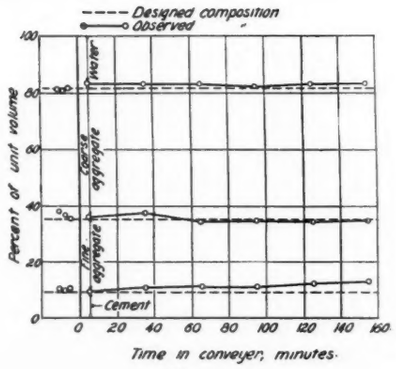


Fig. 5.

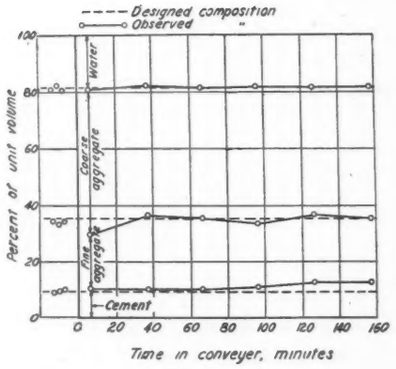


Fig. 6.

moisture were included as part of the 7 gal. The weights of material used in each of the eight batches per charge were: cement 125 lb., sand 292 lb., gravel 520 lb., water 77.5 lb. The concrete was mixed 1½ min. and as it came from the mixer the slump was about 8 in. as is shown at the extreme left in Fig. 1. It was discharged from the mixer into a dump bucket. The dump bucket was hoisted with a crane and dumped into the drum of the conveyor. The two mixers, the conveyor, and the bucket ready to be dumped are shown in Fig. 2.

Every effort was made to mix the batches rapidly, in order that the length of time between the beginning of the mixing and the completion of the charging of the drum might not be too greatly in excess of that which occurs in commercial operation of the conveyor. However, on account of the necessity of weighing all the materials carefully (48 weighings for each charge of the conveyor), the taking of the samples of concrete, and the handling of the concrete with the crane, it was not possible to reduce the time from the beginning of the mixing until the conveyor was charged, to much less than ½ hr. Some improvement was made as the work progressed, as is indicated by the fact that the time required by the successive runs was: Series A, 31 min.; Series B, 32 min.; Series C, 23 min.; and Series D, 19 min. . . .

Methods Used in Testing.—The conveyor was charged with 2 cu. yd. of concrete, for which the quantities of the various constituents were definitely known. Samples were taken of the concrete as it came from the mixer just before it entered the conveyor, and at various time intervals after the conveyor had been charged and in operation. One set of samples was used to determine the slump of the fresh concrete and the compressive strength of the concrete after having been cured for various ages. Another set of samples was used to determine the composition of the freshly-mixed concrete to discover any tendencies toward segregation.

From each sample used to determine the compressive strength, three slump tests were made promptly after taking the samples, and then eighteen 6-in. by 12-in. cylinders were made, three to be tested at each of the following ages; 1, 2, 4, 7, 14 and 28 days. In general, one round of specimens (that is, one specimen for test at each of the above-named ages) was made in paper molds, a second round was made in steel molds, and the third round in paper molds. In general, complete sets of 18 cylinders each were taken at about 7 min. after the conveyor was charged, and at intervals of 30 min. thereafter, except that the last set, taken about 2½ hr. after starting the drum, consisted of only 6 cylinders. As discussed herein, all the cylinders taken at any one of these times constitutes a "set." There were some exceptions to this routine.

In the conveyor run A (Series A) 108 cylinders were made. In each of the runs B, C and D, 114 cylinders were made, making 450 cylinders in all. In taking the samples for all the cylinders of any set, all the concrete for that set was dumped from the mixer or conveyor (as the case might be) into a metal scow-shaped container here termed the "boat." The concrete was then remixed with a hoe

TABLE II.—CONSTITUENTS OF CONCRETE OF SERIES A.

Sample No.	Source	Time in Conv. (*min.*)	Slump (*in.*)	Absolute Volume of Ingredients (*per cent.*)				Parts by Weight			
				Water	Cement	Sand	Gravel	Cement	Sand	Gravel	Total Aggregate
Design				18.34	9.52	25.64	46.50	1	2.33	4.16	6.49
1	Mixer			15.58	9.16	20.96	54.30	1	1.98	5.05	7.03
2	Mixer			17.40	9.39	24.05	49.15	1	2.21	4.46	6.67
3	Mixer		8.0	17.72	10.31	25.02	46.95	1	2.10	3.87	5.97
4	Mixer			18.06	10.08	24.60	47.27	1	2.11	3.99	6.10
5	Mixer										
6	Mixer		8.2	17.76	9.12	24.14	48.99	1	2.06	4.18	6.24
7											
8	Mixer		9.0	18.46	10.72	26.23	44.62	1	2.12	3.54	5.66
9	Conveyor	7	5.5	16.16	10.16	26.76	46.45	1	2.28	3.89	6.17
10	Conveyor	7									
11	Conveyor	40	2.2	17.08	11.12	26.43	45.38	1	2.05	3.43	5.48
12	Conveyor	40									
13	Conveyor	72	3.2	17.87	11.27	21.91	48.95	1	1.68	3.70	5.38
14	Conveyor	72									
15	Conveyor	102	2.1	17.19	11.22	22.22	49.37	1	1.71	3.74	5.45
16	Conveyor	102									
17	Conveyor	132	1.8	18.27	12.28	22.87	46.59	1	1.61	3.23	4.84
18	Conveyor	132									4.39
19	Conveyor	157	1.8	18.56	13.30	23.03	45.11	1	1.50	2.89	

and shoveled from the boat directly into the cylinder molds. Due to the wholesale nature of the program and the consequent pressure of the work, not much attention could be paid to further remixing of the concrete in the boat before placing it in the molds.

Simultaneously (as nearly as possible) with the sampling for compression specimens, other samples were taken for use in determining the composition of the concrete. These latter samples—about 5,000 gr. each—were taken directly from the stream of concrete as it was discharged from the mixer or the conveyor drum, as the case might be. The aim in these analyses was to separate the freshly-mixed concrete into its constituents and to determine the amount of each by weighing. The process consists essentially of:

(a) Weighing the whole sample in air;

(b) Weighing the whole sample in water;

(c) Screening the sample in water by the use of the No. 100 and No. 4 sieves nested, allowing the material passing the No. 100 sieve to be washed away;

(d) Weighing in water the residue on the No. 4 screen; and

(e) Adding to (d)—the residue on the No. 4 sieve—that retained on the No. 100 sieve and weighing in water.

If the specific gravities of the cement, fine and coarse aggregates are not known, their determination constitutes additional operations. All weights are taken in grams. The weights in grams of the coarse and the fine aggregates are found by multiplying by the fraction $\frac{g}{g-1}$, the weight given in (d), and similarly that found by subtracting (d) from (e). In this fraction, g is the specific gravity of the material. The weight of the cement in water is found by subtracting the weight found in (e) from that found in (b). Its weight in air is found by multiplying this difference by the fraction $\frac{g}{g-1}$. The weight of the water is found by subtracting the sum of the weights of the cement and aggregate as here described, from the weight of the total sample given in (a). If all the cement and no aggregate passed the No. 100 sieve, the determinations would be as accurate as are the weighing operations, but, due to the fact that some cement is retained on, and some of the fine sand passes, the No. 100 sieve, corrections have to be made based upon a predetermination of the percentages so retained and passing.

TABLE III.—CONSTITUENTS OF CONCRETE OF SERIES B.

Sample No.	Source	Time in Conv. (*min.*)	Slump (*in.*)	Absolute Volume of Ingredients (*per cent.*)				Parts by Weight			
				Water	Cement	Sand	Gravel	Cement	Sand	Gravel	Total Aggregate
Design				18.34	9.52	25.64	46.50	1	2.33	4.16	6.49
21	Mixer		7.5	18.77	10.76	26.85	43.62	1	2.16	3.45	5.61
22	Mixer		8.0	19.27	9.78	26.83	44.02	1	2.35	3.79	6.14
23	Mixer		6.5	18.24	10.89	24.42	46.18	1	1.97	3.61	5.58
24	Conveyor	5	5.8	16.91	9.97	25.82	47.29	1	2.24	4.03	6.27
25	Conveyor	5									
26	Conveyor	35	4.7	17.79	10.69	26.59	45.03	1	2.15	3.58	5.73
27	Conveyor	35									
28	Conveyor	65	3.2	17.24	11.23	23.10	48.44	1	1.78	3.67	5.45
29	Conveyor	65									
30	Conveyor	95	3.4	17.99	11.25	22.99	47.77	1	1.77	3.61	5.38
31	Conveyor	95									
32	Conveyor	125	1.6	17.44	12.09	21.96	48.49	1	1.57	3.42	4.99
33	Conveyor	125									
34	Conveyor	155	1.3	17.88	13.40	21.86	46.82	1	1.41	2.98	4.39
35	Conveyor	155		17.05	12.99	20.94	49.01	1	1.39	3.21	4.60

Several methods have been devised for analyzing concrete, and that described represents the procedure developed by Prof. Dunagan who was in charge of the determinations of the composition of the concrete. The apparatus developed by Prof. Dunagan for this work is shown in Fig. 3. The results of the composition tests furnish some information on the adaptability of the Dunagan apparatus to the determination of composition of concrete for purposes of inspection. It should be remembered, however, that this was only incidental and that the main purpose was to ascertain whether there was segregation in the conveyor. It is believed that the accuracy of the determinations was sufficient for the latter purpose.

Capping and Curing.—The problems of capping and of curing, up to the time that the caps were hardened, presented serious difficulties. The best laboratory practice is to cap specimens about 5 hr. after they are made and while they are still in the molds, then to leave them in the molds until the caps are hardened. The molds are then removed and the specimens placed in the moist-room to cure until the time of tests. It was not possible to follow this

TABLE IV.—CONSTITUENTS OF CONCRETE OF SERIES C.

Sample No.	Source	Time in Conv. (*min.*)	Slump (*in.*)	Absolute Volume of Ingredients (*per cent.*)				Parts by Weight			
				Water	Cement	Sand	Gravel	Cement	Sand	Gravel	Total Aggregate
Design				18.34	9.52	25.64	46.50	1	2.33	4.16	6.49
47	Mixer		8.0	19.13	9.55	24.66	46.66	1	2.23	4.47	6.70
48	Mixer		9.0	17.76	9.64	23.46	49.14	1	2.10	4.38	6.49
49	Mixer		8.0	19.52	10.34	23.92	46.19	1	1.99	3.79	5.78
50	Conveyor	6	8.5	19.74	10.40	18.68	51.17	1	1.55	4.20	5.75
51	Conveyor	6		18.88	10.46	19.51	51.15	1	1.61	4.16	5.77
52	Conveyor	37	7.5	18.10	10.71	25.66	45.54	1	2.07	3.62	5.69
53	Conveyor	37									
54	Conveyor	66	5.8	18.71	10.94	24.45	45.91	1	1.93	3.57	5.50
55	Conveyor	66									
56	Conveyor	96	3.8	17.94	11.50	21.92	48.65	1	1.65	3.60	5.25
57	Conveyor	96		18.74	11.35	22.44	47.46	1	1.71	3.56	5.27
58	Conveyor	126	3.4	18.68	13.19	23.68	44.45	1	1.55	2.87	4.42
59	Conveyor	126	3.3	18.20	12.74	22.49	46.56	1	1.53	3.11	4.64
60	Conveyor	157		18.69	13.08	22.41	45.82	1	1.48	2.98	4.46
61	Conveyor	157									

TABLE V.—CONSTITUENTS OF CONCRETE OF SERIES D.

Sample No.	Source	Time in Conv. (*min.*)	Slump (*in.*)	Absolute Volume of Ingredients (*per cent.*)				Parts by Weight			
				Water	Cement	Sand	Gravel	Cement	Sand	Gravel	Total Aggregate
Design				18.34	9.52	25.64	46.50	1	2.33	4.16	6.49
62	Mixer		8.0	18.99	9.61	23.81	47.60	1	2.14	4.22	6.36
63	Mixer										
64	Mixer		8.5	18.15	6.79	28.35	46.72	1	3.61	5.86	9.47
65	Mixer										
66	Conveyor	8	8.2	18.69	10.54	23.80	46.97	1	1.95	3.79	5.74
67	Conveyor	8									
68	Conveyor	36	7.0	18.31	11.09	21.99	48.61	1	1.72	3.73	5.45
69	Conveyor	36									
70	Conveyor	68	6.8	17.91	11.26	22.79	48.04	1	1.75	3.63	5.38
71	Conveyor	68									
72	Conveyor	99	5.3	18.26	11.33	22.57	47.83	1	1.60	3.59	5.19
73	Conveyor	99									
74	Conveyor	127	4.0	19.06	14.94	19.35	46.65	1	1.12	2.66	3.78
75	Conveyor	127									
76	Conveyor	159	3.3	18.85	13.00	22.25	45.89	1	1.48	3.00	4.48
77	Conveyor	159									

procedure in this case for several reasons. First, there were so many cylinders made on each of the two days (222 and 228, respectively) and the making of them took until so late in the day that it was not possible to cap them on the same day. Second, on account of the necessity of removing the steel molds for using them again, it was not possible to leave these molds on the specimens while the caps hardened. With the paper molds, it was necessary to cap both the tops and bottoms of the cylinders, and not enough planed steel plates were available to cap them all on one day. It was necessary, then, to put the specimens in the moist-room and wait for a time to cap them.

The specimens tested at 1 day and 2 days were stripped at about 24 hr., capped with plaster of Paris or lumnite cement, and tested without their having been in the moist-room. The 2-day specimens, therefore, stood in the open air of the laboratory for 12 to 24 hr. before testing. The effect of this early drying probably was compensated for, to some extent at least, by the fact that all specimens were immersed and allowed to stand in water for about 1 hr. just prior to testing. All other specimens cast in steel molds were stripped at 24 hr. and placed in the moist-room. Those made in paper molds were placed in the moist-room at 24 hr. with the molds still on. All specimens, except the 1- and 2-day specimens, were removed from the moist-room at a later date, capped with lumnite cement, and returned to the moist-room later on the same day, except that, of Series A and B, the 4-day specimens remained out of the moist-room a little less than 1½ days and the 7-day specimens until the time of testing, or a little more than 2 days. The additional drying was partially compensated for by immersion just prior to testing. Some trouble was experienced in securing satisfactory caps, due, apparently, to the short time allowed for the caps to harden before returning the specimens to the moist-room. It was necessary to recap about 90 of the specimens. The recapping was done with a sulphur compound just before testing.

The moist-room was kept generally at a temperature of 70 deg. F. Owing to trouble with the temperature and moisture control from Thursday noon, Jan. 1, to Saturday night, Jan. 3, the temperature averaged about 63 deg. F.

Constituents of Concrete.—The determination of the constituents of the concrete was made with the apparatus shown in Fig. 3, and the results secured are given in Tables III to VI, and are plotted in Fig. 4 to 8. The accuracy with which each determination was made may be estimated from the uniformity in results of samples taken simultaneously. In Series A 6 samples were taken as the concrete came from the mixer. In Series B and C 3 samples were taken at this time, and in Series D 2 samples. The water content, determined from these 6 samples in Series A, varied from a high value of 18.5 per cent. to a low value of 15.6 per cent. of the volume of the concrete, or from about 1 per cent. higher to 15 per cent. lower than the amount of water used in the mix. The cement content in these samples varied from about 12.5 per cent. higher to 5 per cent. lower, the sand content from 2 per cent. higher to 18 per cent. lower, and the gravel content from 17 per cent. higher to 4 per cent. lower than the amount used in the mix.

Generally, one determination of the constituents of the concrete was made on samples taken at about 7, 37, 67, 97, 127 and 157 min. after the concrete had been placed in the conveyor.

The average results for all series are given in Table VI and plotted in Fig. 8. It is to be noted that the amount of water, determined from the analysis, remained practically constant for the concrete kept in the conveyor for different lengths of time. The tests made on the samples taken from the conveyor show a variation in the amount of water from

TABLE VI.—CONSTITUENTS OF CONCRETE; AVERAGES FOR SERIES A TO D.

Source	Time in Conv. (*min.*)	Slump (*in.*)	Absolute Volume of Ingredients (*per cent.*)				Parts by Weight			
			Water	Cement	Sand	Gravel	Cement	Sand	Gravel	Total Aggregate
Design			18.34	9.52	25.64	46.50	1	2.33	4.16	6.49
Mixer		8.0	18.20	9.72	24.80	47.24	1	2.22	4.19	6.34
Conveyor	7	7.0	18.07	10.31	22.91	48.61	1	1.93	4.01	5.94
Conveyor	37	5.4	17.82	10.90	25.16	46.14	1	2.00	3.59	5.60
Conveyor	68	4.8	17.93	11.17	23.06	47.83	1	1.78	3.64	5.43
Conveyor	98	3.6	18.02	11.33	22.43	48.22	1	1.69	3.62	5.31
Conveyor	127	2.7	18.36	13.12	21.96	46.54	1	1.46	3.04	4.51
Conveyor	157	2.4	18.21	13.09	22.16	46.54	1	1.47	3.03	4.49

about 0.5 per cent. higher to 3 per cent. lower than the amount used in the mix.

The observed cement content increased quite regularly during the time in the conveyor. The value increased from about 2 per cent. higher to 38 per cent. higher than the amount used in the mix from the time the concrete was placed in the conveyor until the end of the 2½-hr. period. This must be due to an increase in the amount of very fine aggregate, passing the No. 100 sieve, during the rotation of the conveyor drum. This is confirmed by the fact that the observed apparent increase in the amount of cement was nearly equal to the decrease in the amount of sand. Evidently the mixing and churning action within the drum was sufficient to pulverize a portion of the ingredients until, at the end of the run, the increase in the absolute volume of aggregate passing the No. 100 sieve amounted to about 36 per cent. of the absolute volume of the cement. Such an increase in amount of fine particles would be expected to make the concrete appear richer, to decrease the slump, and probably to increase the strength of the concrete.

The average observed sand content varied from about 2 per cent. lower to 14 per cent. lower than the amount used in the mix. The sand content showed a general downward trend with the increase in length of time in the conveyor, but the results were not so consistent as the increase found in the cement content. The sum of the cement and sand had a slight upward trend, indicating that the quantity of material smaller than the No. 4 sieve increased during the time in the conveyor. The conveyor, therefore, seemed to have some grinding effect upon both the coarse and the fine aggregates. An increase in the amount of aggregate passing the No. 4 sieve would indicate only abrasion of the coarse aggregate, but the increase in the amount passing the No. 100 sieve could indicate pulverizing of both coarse and fine aggregates.

The average observed gravel content varied from about 4.5 per cent. higher to 1 per cent. lower than the amount used in the mix. The general tendency was toward a slight decrease in the amount of gravel during the time in the conveyor drum. The line representing the sum of the cement, the sand and the gravel (see Fig. 8) is practically horizontal for the length of time in the drum. This indicates that the amount of solid materials in the mix remained constant, and adds to the confidence in the accuracy of the results obtained.

To furnish a comparison of the action of the conveyor drum with that of the mixer, a batch of the same proportions as those used in the conveyor was placed in one of the Jaeger mixers and the mixer was run for 1 hr. 15 min. at the same rate as that employed in the mixing for Series A, B, C and D. No slump tests or compression specimens were made. Samples for the determination of the composition were taken at intervals during the operation of the mixer. The results of these tests are given in Fig. 9, from which it will be seen that the sum of the cement and the aggregates remained practically constant. The water also remained constant within the limits of accuracy of the determinations. The apertures for charging and discharging remained open during the operation of the mixer, and there was no protection against evaporation. However, judging from the irregularity of the graph for the amount of water, it appears that as much as 10 per cent. of the water (about 1 gal.) could have been lost without being detected by this apparatus.

The apparent increase in the cement was even more marked than that which occurred in the conveyor drum as shown in Fig. 4 to 8. Apparently the pulverizing action in the mixer was more pronounced than that in the conveyor drum. Whereas in the conveyor the absolute volume of the aggregate which was pulverized sufficiently to pass the No. 100 sieve was about 36 per cent., in the mixer the corresponding quantity passing the No. 100 sieve was 72 per cent. of the absolute volume of the cement, or twice as much as with the conveyor. Al-

TABLE VII.—CONSTITUENTS OF CONCRETE; KEPT IN MIXER FOR 1 HR. 15 MIN.

Sample No.	Source	Time in Mixer (*min.*)	Absolute Volume of Ingredients (*per cent.*)				Parts by Weight			
			Water	Cement	Sand	Gravel	Cement	Sand	Gravel	Total Aggregate
Design			18.34	9.52	25.64	46.50	1	2.33	4.16	6.49
36	Mixer	½	21.22	8.83	22.89	47.06	1	2.24	4.54	6.78
37	Mixer	¾	18.08	9.26	24.76	47.90	1	2.31	4.40	6.71
38	Mixer	1¼	18.77	8.94	22.85	49.44	1	2.21	4.71	6.92
39	Mixer	1¼	18.86	9.61	24.78	46.75	1	2.23	4.14	6.37
40	Mixer	1½	17.63	9.50	23.35	49.54	1	2.13	3.44	5.57
41	Mixer	2	19.19	10.47	26.54	43.80	1	2.19	3.56	5.75
42	Mixer	2½	19.01	10.63	25.54	44.82	1	2.08	3.59	5.67
43	Mixer	5	17.92	10.48	24.04	47.56	1	1.98	3.86	5.84
44	Mixer	15	18.23	12.31	21.22	47.24	1	1.49	3.34	4.83
45	Mixer	45	17.78	15.25	19.21	47.76	1	1.09	2.67	3.76
46	Mixer	75	20.14	16.36	17.53	45.99	1	0.93	2.39	3.32

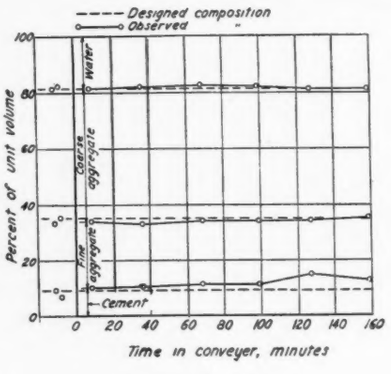


Fig. 7.

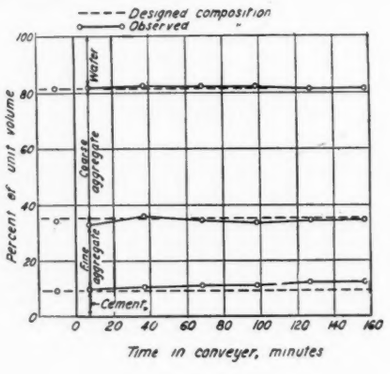


Fig. 8.

though the time of running the mixer was only about half as long as that of the conveyor drum, the rate of rotation was about twice as great, so that there was approximately the same number of revolutions in the two cases.

The test was discontinued after 1 hr. 15 min. because the mix had become so stiff that the concrete stuck to the blades and could not be discharged from the mixer. It was supposed at the time, that the stiffening was due, at least partly, to evaporation of the mixing water, but the results shown in Fig. 9 indicate that the more important factor was the increase in the amount of aggregate passing the No. 100 sieve.

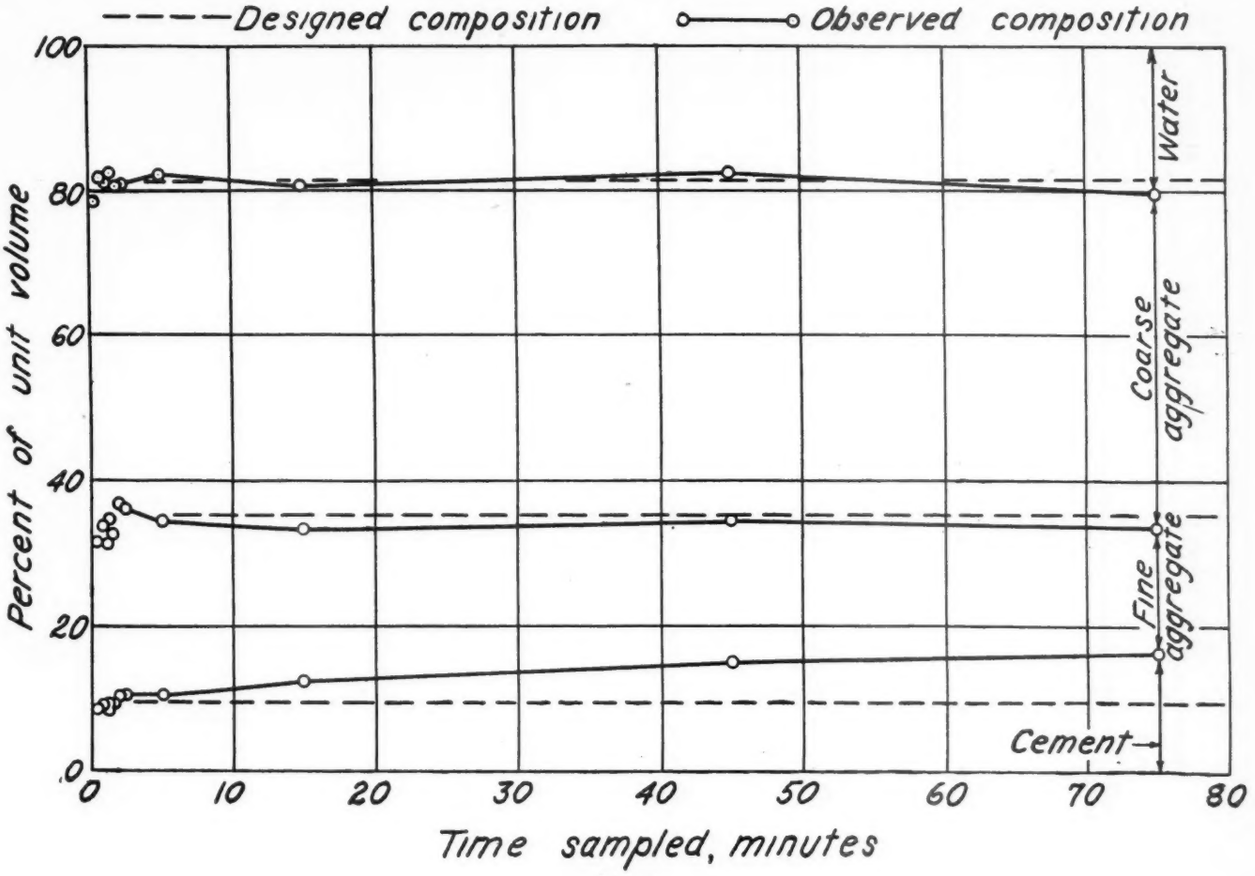


Fig. 9.

TABLE VIII.—SLUMP AND STRENGTH, SERIES A.

Specimen No.	Average Slump (*in.*)	Elapsed Time: In Conveyor (*min.*)	Elapsed Time: After Sampling[1] (*min.*)	Compressive Strength (*lb. per sq. in.*): 1 da.	2 da.	4 da.	7 da.	14 da.	28 da.
MA1			0	177	432	949	1903	2980	4380
MA2	8.4	9	8	181	309	1056	1772	3184	3981
MA3			15	202	532	1221	2148	3511	4133
Avg.				187	424	1075	1941	3225	4165
7A1			10	224	496	1226	2062	2553	3710
7A2	5.5	7	17	292	490	....	1857	3043	4285
7A3			25	164	372	957	1699	2210	4345
Avg.				227	453	1092	1873	2602	4113
8A1			6	214	445	1259	2291	2737	4344
8A2	2.3	40	15	219	492	1317	2100	3706	4264
8A3				.....	.....	.....	.....	.....	.....
Avg.				216	468	1288	2196	3222	4304
9A1			6	253	449	1473	2463	2793	4420
9A2	3.3	72	16	.....	644	1570	2597	3621	4533
9A3			26	233	490	1394	2132	2474	4677
Avg.				243	528	1479	2397	2963	4543
10A1			6	295	594	1612	2165	3051	3802
10A2	2.1	102	15	233	777	1784	2832	4140	4955
10A3			25	298	634	1753	2600	2954	4849
Avg.				275	668	1764	2532	3382	4535
11A1			6	411	778	1754	2815	4228	4831
11A2	1.8	132	15	396	898	2026	3137	3735	4956
11A3			21	386	714	1930	2832	3522	4673
Avg.				398	797	1903	2928	3828	4820
12A1	2.0	157		421	873	1754	2441	3003	4874

[1]Time from removal of concrete from conveyor until last cylinder of set had been molded.

Note.—All specimens whose numbers end in 1 and 3 were made in paper molds, all those ending in 2 were made in steel molds.

The results of these tests were somewhat unexpected, but they are consistent with each other. There seems to be no reason for suspicion of the results, but they should be used with caution, since no repetition of the test was made for the purpose of securing confirmatory data.

Slump Tests.—Three slump tests were made on each of the concrete samples taken for each set of compression specimens, that is, at the time of charging the conveyor and at successive intervals after the concrete had been placed in the conveyor. Fig. 1 shows photographs of representative slump specimens taken at successive intervals in Series B and C. The specimens were assembled and photographed after they had hardened. The slumps thus measured from each sample are shown in Tables VIII to XI, and Fig. 10 to 13 for each series of tests in which each value is the average for three tests made at the time of a given sampling. The average results from all four series are shown in Table XII and Fig. 14. It is noted that on the first day of the test with both cements, the slump decreased faster during the first 30 min. in the conveyor than during

TABLE IX.—SLUMP AND STRENGTH, SERIES B.

Specimen No.	Average Slump (*in.*)	Elapsed Time: In Conveyor (*min.*)	Elapsed Time: After Sampling [1] (*min.*)	Compressive Strength (*lb. per sq. in.*): 1 da.	2 da.	4 da.	7 da.	14 da.	28 da.
MB1			0	198	403	1007	1441	2507	3033
MB2	7.3	0	10	.....	404	837	1260	2337	3287
MB3			18	314	670	1357	2177	2913	3445
Avg.				256	492	1067	1626	2586	3255
1B1			5	204	424	938	1712	2262	2900
1B2	5.8	5	10	175	482	1166	1751	2733	3233
1B3			17	264	408	1048	1896	2462	3590
Avg.				214	438	1051	1786	2486	3241
2B1			5	212	530	1237	1850	2603	3208
2B2	4.7	35	13	226	529	1196	2060	3023	3809
2B3			19	195	511	1229	1720	2133	3317
Avg.				211	523	1221	1877	2586	3445
3B1			5	238	581	1251	2142	3020	3243
3B2	3.2	65	10	256	688	1312	1990	3145	4218
3B3			13	269	491	1366	1892	2110	3285
Avg.				254	587	1310	2008	2758	3582
4B1			5	277	564	1464	1960	2720	3914
4B2	3.4	95	8	307	855	1626	2533	2915	4326
4B3			15	311	653	1624	2050	2428	3783
Avg.				298	691	1571	2181	2688	4008
5B1			4	323	788	1575	2070	2690	3886
5B2	1.6	125	12	365	759	1850	2605	3150	4174
5B3			16	329	754	1696	2417	3163	4020
Avg.				339	767	1707	2364	3001	4027
6B1	1.3	155	10	386	697	1767	2262	3260	4245

[1]Time from removal of concrete from conveyor until last cylinder of set had been molded.

Note.—All specimens whose numbers end in 1 and 3 were made in paper molds, all those ending in 2 were made in steel molds.

the remaining periods. On the second day of the tests, however, both cements showed a more uniform decrease in slump from the time of charging the conveyor until the end of the test. This difference may be due, partly, to the difference in weather conditions on the two days of the tests. On the first day there was a decrease in slump from about 8 to 1¾ in. during the total period in the conveyor, and on the second day a decrease from about 8 to 3 in. during the same period. The average for all series (plotted in Fig. 8) showed a uniform decrease in slump from about 8 to 2¼ in. during the time in the conveyor. The cause of this decrease in slump of the concrete during its stay in the conveyor may be found, partly, in the fact that the amount of very fine materials increased as pointed out in "Constituents of Concrete."

The visual inspection of the concrete at the time of taking each sample indicated that the concrete stiffened and gave the appearance of becoming richer and more plastic during its stay in the conveyor. The workability of the mix, therefore, probably decreased less than is indicated by the slump test. In fact, as judged by the ease of placing the concrete in the molds, it was in general as workable at the end of 1 hr. as when it came from the mixer and would be less subject to segregation in the forms. Series A showed unusual stiffness at the second sampling, that is, at 37 min. The stiffening

TABLE X.—SLUMP AND STRENGTH, SERIES C.

Specimen No.	Average Slump (*in.*)	Elapsed Time: In Conveyor (*min.*)	Elapsed Time: After Sampling [1] (*min.*)	Compressive Strength (*lb. per sq. in.*): 1 da.	2 da.	4 da.	7 da.	14 da.	28 da.
MC1			0	91	269	756	1350	2258	2800
MC2	8.3	0	2	98	231	836	1537	2592	3156
MC3			4	113	236	738	1320	2213	2474
Avg.				101	305	777	1402	2354	2810
1C1			1	141	300	742	1462	2140	2296
1C2	8.3	6	15	152	365	1120	1826	2578	3898
1C3			22	121	321	862	1578	2817	3200
Avg.				138	329	908	1622	2512	3131
2C1			5	158	409	888	1899	2575	3162
2C2	7.4	37	8	164	452	1230	2052	3080	3432
2C3			10	160	408	1073	2002	2975	3242
Avg.				161	423	1064	1984	2877	3279
3C1			5	159	465	1175	2129	2822	3908
3C2	6.0	66	8	161	569	1331	2085	3114	3752
3C3			15	177	406	1232	2230	2824	2960
Avg.				166	480	1246	2148	2920	3540
4C1			6	174	512	1234	2193	3055	3778
4C2	3.6	96	8	183	600	1533	2382	3721	4025
4C3			10	203	600	1466	2452	3303	3766
Avg.				187	571	1411	2342	3360	3856
5C1			7	216	653	1542	2675	3377	4082
5C2	3.2	126	9	217	674	1799	2960	3865	3765
5C3			11	221	689	1657	2715	3537	4111
				218	672	1666	2783	3593	4319
6C1	3.0	157	6	257	699	1885	2726	3799	3889

[1]Time from removal of concrete from conveyor until last cylinder of set had been molded.

Note.—All specimens whose numbers end in 1 and 3 were made in paper molds, all those ending in 2 were made in steel molds.

is indicated in the slump curve of Fig. 10. No other series showed so rapid stiffening, although the observation was that the stiffening was more rapid on the first than on the second day's run. Beyond the 1-hr. period, even up to the end of the run, the concrete remained plastic. It would require more work to place it in reinforced concrete construction, but

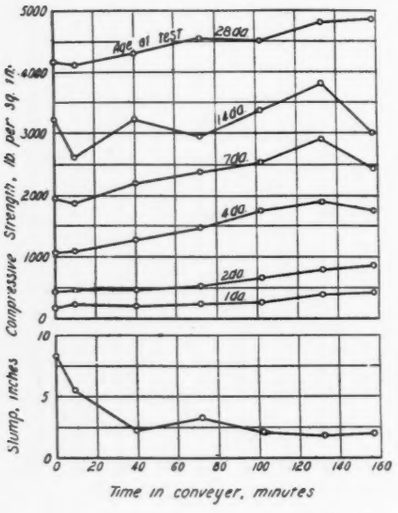


Fig. 10.

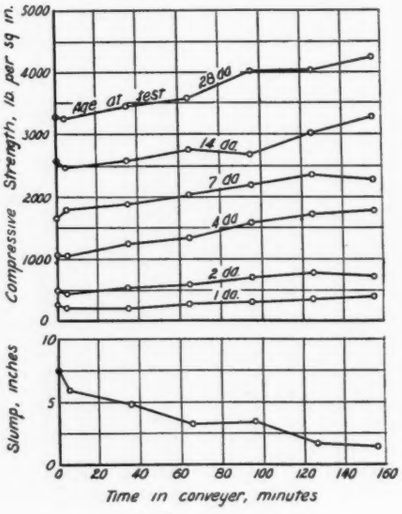


Fig. 11.

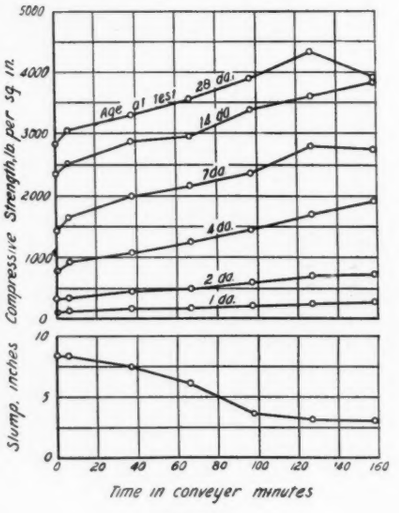


Fig. 12.

for roads and pavements it seemed entirely adaptable. For the latter purpose it would be vastly superior to the concrete as it came from the mixer. To have secured directly from the mixer, with the same materials, a concrete of as good workability and as high strength as that which came from the conveyor after 2 hr. of transportation a higher cement content would have been necessary.

Compressive Strength.—Three 6-in. by 12-in. cylinders from each sample were tested at each of the ages: 1, 2, 4, 7, 14 and 28 days for each series. The strength of these cylinders is given in Tables VIII to XI and are plotted in Fig. 10 to 13, for Series A, B, C and D, respectively. Each value given is the average for the three companion cylinders except the last, which represents the strength of the one cylinder taken after 2½ hr. in the conveyor. The average strength for all series is given in Table XII and Fig. 14. It is noted that the strength of the concrete at all ages increased quite consistently with the increase in the time the concrete had been in the conveyor prior to the taking of the samples. The average increase in strength from the time of placing the concrete in the conveyor until the end of the 2½-hr. period was nearly 100 per cent. for the 1-day tests, 90 per cent. for the 2-day tests, and about 80 per cent. for the 4-day tests. For the 7-, 14- and 28-day tests the increase in strength was nearly the same amount (700 to 800 lb. per sq. in.) as for the 4-day tests. That is, the time-strength curves were practically parallel for ages above 4 days. The action of the conveyor had, therefore, a beneficial effect in so far as the concrete which remained 2½ hr. in the conveyor had its strength materially increased. The reason for this increase is partly to be found in the fact that the amount of very fine aggregate particles—amount passing the No. 100 sieve—increased considerably during the time in the conveyor.

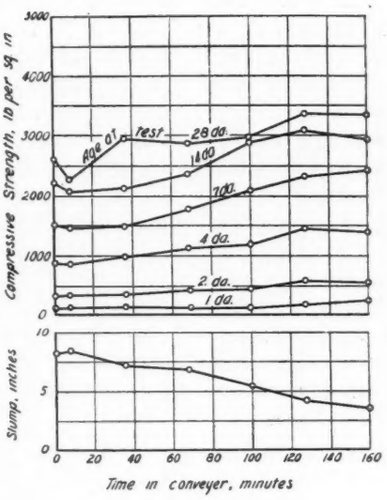


Fig. 13.

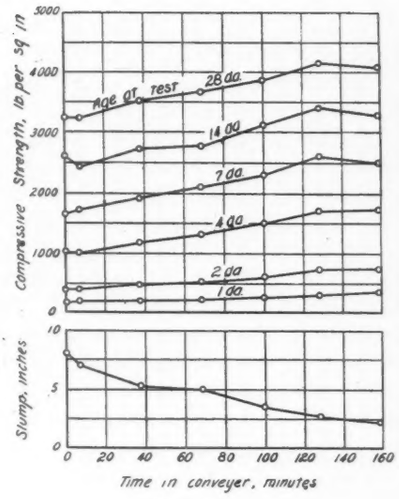


Fig. 14.

TABLE XI.—SLUMP AND STRENGTH, SERIES D.

Specimen No.	Average Slump (*in.*)	Elapsed Time: In Conveyor (*min.*)	Elapsed Time: After Sampling[1] (*min.*)	Compressive Strength (*lb. per sq. in.*): 1 da.	2 da.	4 da.	7 da.	14 da.	28 da.
MD1			0	91	236	586	961	1496	1815
MD2	8.0	0	5	155	520	1335	2187	3225	4026
MD3			10	106	245	730	1278	1914	1998
Avg.				117	334	884	1475	2212	2613
1D1			5	120	306	847	1289	2072	2179
1D2	8.2	8	8	138	375	945	1668	2030	2693
1D3			11	129	337	804	1413	2122	1967
Avg.				129	339	865	1457	2075	2280
2D1			6	145	320	910	1582	2268	3074
2D2	7.0	36	9	149	433	1134	1620	2270	2924
2D3			11	138	295	874	1214	1811	2808
Avg.				144	349	973	1472	2116	2935
3D1			4	129	445	1014	1600	2520	2550
3D2	6.6	68	6	127	392	1217	1947	2065	3184
3D3			10	137	401	.....	1790	2482	2881
Avg.				131	413	1116	1779	2356	2872
4D1			5	129	410	.....	1915	2880	2822
4D2	5.3	99	8	134	454	1268	2014	3013	3037
4D3			10	130	443	1096	2282	2780	2997
Avg.				131	436	1182	2070	2891	2952
5D1			5	189	523	1440	2133	2849	3318
5D2	4.0	127	7	186	623	1544	2405	3286	3682
5D3			9	188	574	1306	2407	3106	3084
Avg.				188	573	1430	2315	3080	3361
6D1	3.3	159	6	227	542	1378	2418	2925	3338

[1] Time from removal of concrete from conveyor until last cylinder of set had been molded.

Note.—All specimens whose numbers end in 1 and 3 were made in paper molds, all those ending in 2 were made in steel molds.

General Comments.—In judging the conveyor on the basis of these tests, account should be taken of the fact that some of the conditions varied from those to which the conveyor would be subjected in practice. In general, the variations from working conditions probably constituted somewhat of a handicap upon the most efficient operation of the machine, while in certain cases they might be favorable to the production of better results than in practical operation.

TABLE XII.—SLUMP AND COMPRESSIVE STRENGTH; AVERAGE FOR SERIES A TO D.

Specimen No.	Slump (*in.*)	Time in Conveyor (*min.*)	Compressive Strength (*lb. per sq. in.*): 1 da.	2 da.	4 da.	7 da.	14 da.	28 da.
M	8.0	0	165	389	951	1611	2594	3211
1	7.0	7	177	390	979	1685	2419	3191
2	5.3	37	183	441	1136	1882	2700	3491
3	5.0	68	198	502	1288	2083	2749	3634
4	3.6	98	223	592	1482	2281	3080	3838
5	2.7	127	286	702	1677	2598	3376	4132
6	2.3	157	323	703	1696	2462	3247	4086

TABLE XIII.—OUTDOOR TEMPERATURES AT LEHIGH UNIVERSITY DURING THE CONVEYOR TEST.

Date	Time	Temperature (*deg. F.*)	Date	Time	Temperature (*deg. F.*)
Dec. 29	8:00	26	Dec. 30	2:00	32
	10:00	29		4:00	32
	12:00 Noon	31		6:00	30
	2:00	31		8:00	28
	4:00	31	Dec. 31	8:00	22
	6:00	30		10:00	24
	8:00	30		12:00 Noon	28
Dec. 30	8:00	30		2:00	32
	10:00	31		4:00	32
	12:00 Noon	32		6:00	28
				8:00	28

The length of time between the beginning of the mixing and the final charging of the conveyor was unavoidably considerably greater in all the series than that which should be expected in practical op-

eration. This might be expected to shorten the length of time that the concrete could remain in the conveyor during transportation without stiffening up to such an extent as to make it unworkable. On the other hand, if the principal cause of the stiffening of the mix was the pulverizing of the aggregate, it is not certain that the length of time required for mixing the charge was of great importance.

The temperature on both days of the test was quite low for concreting operations. The temperatures, as furnished by the local station of the Weather Bureau, are given in Table XIII. The exposure of the concrete to these low temperatures for 2½ hr. just after mixing the ingredients might have some effect in lowering the strength of the concrete, though in the results there is no evidence on this point. On the other hand, the low temperature might retard the setting of the cement and thus increase the length of time during which transportation in the conveyor could continue without stiffening of the concrete.

In ordinary operation the entire charge is emptied at one time, while in these tests the charge was gradually decreased in size, due to the taking of samples, until, at the end of the run, there was not much more than about 60 per cent. of the original charge in the drum. It is difficult to judge whether this would increase or decrease the effectiveness of the equipment in maintaining or improving the quality of the concrete. In fact, this comment may be applied to all the conditions mentioned in the preceding paragraphs of this section. The purpose here is merely to direct attention to the fact that conditions varied somewhat from those which would prevail in practice.

During the third run of the conveyor, that is, Series C, Prof. Dunagan and the writer inspected the condition of the concrete in the conveyor at one of the times when it returned to the laboratory for the taking of samples. This inspection was made by opening the "filler door" and observing the appearance of the concrete and its behavior when the discharge door was opened. The aggregate appeared to be suspended uniformly in a fairly stiff mortar with no free water in sight. The consistency appeared uniform and there was no sign of segregation. When the discharge door was opened, the first movement of the concrete which was apparent was quite general, but very slight over the greater part of the exposed surface. Soon a somewhat "cone-shaped" portion of the concrete broke away from the rest, due to the flow through the discharge opening. The sample received in the boat resembled closely the surface of the concrete in the drum as viewed through the filler-door aperture.

Summary of Results.—The slump was generally about 8 in., as the concrete came from the mixer, but decreased very consistently during the time that it was in the conveyor drum. Even after 2½ hr. in the conveyor, the consistency was such that the concrete could have been used quite satisfactorily for road or pavement work, where the requirements are particularly rigid.

The amount of water and the sum of the absolute volumes of the cement and aggregates remained practically constant throughout each run. The amount of cement, however, appeared to increase. As this apparent increase was about the same as the decrease in the absolute volume of the sand, it is likely that it was due to the pulverizing of the aggregates, especially the sand.

The apparent increase in cement content in a batch of concrete mixed in a Jaeger mixer for 1 hr. 15 min. was much greater than that in the drum of the conveyor and the stiffening of the batch was correspondingly more marked.

There was no indication of segregation of the concrete in the conveyor drum as observed visually, or as determined by testing the composition of the concrete.

The strength of the concrete from samples taken at successive intervals after charging the conveyor drum, increased progressively according to the length of time during which the sample had been transported in the conveyor. The difference between the length of time of initial set of the two cements used had no effect on the behavior of the conveyor so far as such effects could be observed or measured in a test of this sort.

Suggestions for the Prevention of Coal-Dust Explosions

Some useful hints on the prevention of coal-dust explosions are contained in a letter written by W. P. Rice, superintendent of the Crescent Portland Cement Co. plant at Wampum, Pa., to the National Safety Council. Says Mr. Rice:

"Almost everyone using powdered coal knows its hazards, and that the explosions are caused by a proper mixture of powdered coal and air becoming ignited by some means. The methods of preventing these explosions fall in two general classes: (1) The elimination of the source of ignition; (2) preventing the mixture of coal dust and air in explosive proportions.

"The most obvious, easiest and most discussed is the first, the prevention of ignition. The rule against the use of open flames near coal dust is generally understood and enforced, so needs little discussion. Electrical sources of ignition are more likely to be overlooked. Faulty lamp cords that may cause a spark, the breaking of lamp globes, arcing brushes on motors and electrical tools are means of ignition that need careful watching.

"The coal-drier is often the means of starting an explosion, and requires careful control. The use of temperature-recording instruments that will indicate the temperature of coal discharged from the drier are highly recommended. The temperature should be kept well below the ignition point of the coal.

"When a fire does occur in the drier, the first thought should be to exclude the air by closing the stack dampers or by other means. The obvious method of putting out the fire is to use water, but it is much better and more convenient to spray the water on the fire in the furnace, not the drier, and

(*Continued on page 64*)

Digging for Money—Part I

By JOHN J. ZOLLINGER
Superintendent, South River Sand Co.

John J. Zollinger.

THE failure of a sand-and-gravel operation has a very significant influence on the entire industry, for the reason that it is a visible failure. A shoe store, a machine-shop or almost any enterprise may fail without the public being cognizant of the fact, but a dead sand-and-gravel plant is a desolate memorial testifying for years to erroneous judgment and the waste of money.

This fact has made it difficult to obtain capital for worth-while operations, which are started by men who know the business. Driving through a certain part of the country, I noticed three different plants in this desolate condition, all within a few miles of each other. Upon investigation it was found that one was in the hands of a bank, the other two were financed by private local capital. Although conditions seem fairly favorable for a successful sand-and-gravel business, the three failures will prove a tremendous obstacle to obtaining financial support in that locality.

The opening of a plant is unlike most commercial undertakings, since even the smallest operation represents a good-sized investment. Optimism may be a splendid characteristic, but it tends to underestimate the cost of the undertaking and so cause failure for lack of funds. Errors of judgment are all too frequent and much practical experience is necessary to enable anyone to proceed with intelligence and an assurance of success. The time of guess-work is gone, the experimental stage has passed. We have arrived at the scientific-production era with laboratories and testing facilities. The small producer may still find a meager local market for inferior aggregate but he will find himself only a few feet ahead of the sheriff.

It is surprising how many new plants are started without forethought and planning. There seems to be an erroneous belief that the one business where mistakes and miscalculations do not count is the sand-and-gravel business. They will learn, of course, that somewhere something is wrong but, in the meantime, nothing constructive has been added to the industry in general; on the contrary, the undertaking has damaged the prestige of a great business.

I would like to express the opinion of a business man engaged in quite a different line, when I took him to a newly-constructed plant ready for operation. This particular plant uses a drag-line, screens boulders and everything else on a vibrating screen, has a bucket-elevator leading to the top of the plant, does wet screening and discharges into bins and from the bins into trucks. It has a 2-mi. haul to the dock, dumps the material on the ground, and picks it up with a clam-shell bucket to load it into a barge. After some calculation my friend remarked, "If this man makes money, there is something wrong with the business."

Of course, there is nothing wrong with the business. We certainly can not make money unless we calculate very closely. Prices are cut as low as we can stand. The expressed opinion of a local machine-shop operator, that "any damn fool can make money in the sand-and-gravel business," does not coincide with my experience.

It is necessary to keep in mind that this business can not be made profitable unless we are aware from the start that the profits are not phenomenal but that, as in every other industry, success depends on intelligent operation, constant improvements, a first-class product, and a ready market.

Since a sand-and-gravel operation necessarily depends on the deposit, some really wonderful deposits, owing to their geographical situation, can not profitably be mined at the present time. On the other hand, comparatively poor deposits may be successfully operated owing to their locations, which practically preclude competition. These, however, are rare cases, and more or less competition will always be encountered.

The purpose of this series of articles is to bring out the main reasons for the successful operation of a plant, and for this reason I shall discuss three plants which have made money and of which the profits for three years have been accounted for, that is, if in one season they fell off, the reason was traced to its source and corrected so that, after these experiments, no guess-work is necessary to make a plant pay.

Profits much larger than those that I shall be able to cite have been made, but this does not obscure the issue. The idea is to make profits that are attractive to outside capital, and to make these profits consistently rather than to owe them to favorable circumstances.

Probably at no time will the large producers eliminate the small plants. These, in my mind, are often fully justified, since they are able to supply a demand in a locality, which can not be served as cheaply by the large producer on account of freight charges, repeated handling, etc. The 500-to-1,000-ton-per-day plant, therefore, has its definite place and, I might say, some of these small plants are more intelligently operated than some of the big ones I have seen. That is natural, since the large

producer has a greater margin of profits, and a few mistakes can be made up quickly, whereas the small-plant operator can not afford to go wrong many times before he goes wrong altogether; hence the abandoned small plants mentioned before. You may ask a plant owner how much it has cost him to erect his particular plant, and he will tell you a sum three times the amount you would judge to be the cost of the lay-out. And he may not exaggerate at that, for it probably has cost him that much; his profits have gone into continual changes, new construction and new methods, some for the better and others not so good. Two seasons should prove a plant and make it a permanent installation.

The method of digging the material and conveying it to the plant depends on many factors. We may be thoroughly familiar with a certain method, and this fact may render us prejudiced against another, which, if we knew as much about it, would prove to be a better way. An instance comes to my mind where a man asked me to look over a deposit and settle the question of excavation. It consisted of a 50-ft. bank above water with plenty of water available. However, the bank was filled with big stones and it looked about the same below water level. He had made up his mind to using an 8-in. pump, which I pointed out to him was too small to handle the big stones. The suggestion to work the bank first and prove his plant for a season, or until he had exhausted the material above water, did not sound very good to him; it seemed such a simple thing to pump and have that big bank cave down. He listened and went ahead with the 8-in. pump. Today he is working the dry bank with a 1½-cu.yd. shovel and expects to put in a 12-in. pump when the time comes to get at the lower deposit, which goes to show that we do learn by experience.

The type of plant is defined by its method of obtaining the raw material; it is either a dry operation, a dredging operation, or a combination of both. The last-named has its advantages in the case of "oversize," which may be crushed before it is picked up by the pump. Quite a few plants have lately adopted this method of operation. It is especially adapted for situations where it is necessary to carry material underneath highways. I know one case where the deposit is located on one side of a state highway and the screening-and-loading plant on the other. A 24-in. pipe is laid underneath the pavement and the 10-in. dredge-pipe is fed through it. That leaves a good clearance in case the pipe must be renewed on account of wear. The primary crushing is done on the digging side of the road, above a concrete sump. The pump is located below the pit so that it is self-priming and very efficient. An ingenious device, which I shall describe later, is used to keep the pump from overloading.

A dredging operation has the advantage of simplicity. The material receives a better washing and this simplifies screening, since the loam and possible clay have disintegrated and become loose. A simple pipe does the work of conveyors and, with additional clear water for rinsing, a very good product may be obtained at a good profit.

A dry operation requires more handling, but has the advantage of capacity with a smaller investment in the pit. Also, as an operator told me not very long ago, "when you get it in the bucket and see it on the belt you got it, but when you pump it through a pipe you never know where it is." A sort of bird-in-the-hand proposition, according to him.

If the deposit above water is large enough to be handled dry the amount under water is small, pumping is expensive, inasmuch as only from 20 to 30 per cent. solids are conveyed and the 70 or 80 per cent. water might be handled with a more efficient pump closer to the screening plant. All these points must be considered before determining the mode of excavation.

Another point to be determined is whether a straight suction pump will work satisfactorily or whether a cutter of one type or another should be used. If the deposit consists of gradings from sand to gravel, a straight suction will work well, but if the material is of uniform texture—that is, sand of uniform grading and mostly fine—a cutter will increase production tremendously, as a straight suction will simply dig post-holes, the angle of repose of the material being so near perpendicular that the material will not cave readily. In river dredging a cutter is almost always necessary, since the deposit is generally an unknown quantity. Clay layers and fine strata of sand provide difficulties for straight suction pumps, which will result in unprofitable production. As the additional cost of a cutter is practically equal to the cost of the pump equipment and its operation and wear contribute an appreciable share to production cost, thorough investigation should precede the decision to install such equipment.

Preventing Coal-Dust Explosions

(*Continued from page 62*)

allow the resultant steam to smother the fire in the drier.

"The second general method of eliminating explosions is by preventing the proper mixture of coal dust and air by keeping the driers, grinders, elevators, conveyors and tanks as nearly dust-tight as possible, and this is necessary for general appearance as well as safety.

"A study of coal-dust accidents proves that the secondary explosions are the most disastrous. These are caused by the concussion of the first small explosion dislodging the accumulated dust on the building and machinery structure. This dust in falling becomes ignited and spreads the explosion over the whole room, often wrecking the building and burning men who would otherwise have been out of range. When the roof is blown off, or windows, doors and walls blown out, it is almost always the result of the secondary explosion. The only remedy for this is cleanliness, not only in the easily-accessible places but in every nook and cranny of the building. As a means to this end, painting the entire inside of the building white is strongly recommended. Then an accumulation of coal dust can hardly be overlooked.

MEN OF THE INDUSTRY

The portrait printed on this page in each number of PIT AND QUARRY is selected without significance as to current events or the position of the individual in the industry.

H. P. BROWN
President and General Manager
Diamond Springs Lime Co.
Diamond Springs, Cal.

Coming Events

Sept. 10, 1931. St. Louis, Mo. Monthly meeting, St. Louis Quarrymen's Assn., Forest Park Hotel. E. J. McMahon, exec. sec., 4063 Forest Park Blvd., St. Louis, Mo.

Sept. 28-Oct. 1, 1931. Salt Lake City, Utah. Annual meeting, American Assn. of State Highway Officials.

October 12-16, 1931. Chicago, Ill. National Safety Congress. W. H. Cameron, secretary, National Safety Council, 20 N. Wacker Drive, Chicago, Ill.

Oct. 19-23, 1931. Pittsburgh, Pa. Thirty-seventh annual convention, American Society of Municipal Engineers, William Penn Hotel, Geo. M. Lehman, secretary, 420 City-County Bldg., Pittsburgh, Pa.

Jan. 9-15, 1932. Detroit, Mich. Annual Convention and show, American Road Builders Assn. Chas. M. Upham, engineer-director, National Press Bldg., Washington, D. C.

Jan. 19-22, 1931. Pittsburgh, Pa. Annual Convention, National Crushed Stone Assn., Wm. Penn Hotel. J. R. Boyd, secretary, Merchandise Bldg., Washington, D. C.

Jan. 25-26, 1932. Pittsburgh, Pa. Annual convention, National Ready-Mixed Concrete Assn., Wm. Penn Hotel. V. P. Ahearn, executive secretary, Munsey Bldg., Washington, D. C.

Jan. 27-29, 1932. Pittsburgh, Pa. Annual convention, National Sand & Gravel Assn., Wm. Penn Hotel. V. P. Ahearn, secretary, Munsey Bldg., Washington, D. C.

Feb. 3-4, 1932. Washington, D. C. Annual meeting, Sand-Lime Brick Assn. Ellen Knight, sec., 321 N. Hamilton St., Saginaw, Mich.

Feb. 23-26, 1932, Wichita, Kan. Seventh Annual Southwest Road Show and School.

Feb. 23-26, 1932. Washington, D. C. Annual convention, American Concrete Institute, Wardman Park Hotel. Harvey Whipple, sec., 2970 West Grand Blvd., Detroit, Mich.

Pumpings from the Old Pit

Excerpts from the old files of PIT AND QUARRY *reveal many interesting sidelights on the activities of the pits, quarries and plants of former days. These are printed in this column each issue.*

Fourteen Years Ago

BURT SCOTT, formerly superintendent of the municipal light and water plant at Williamsport, Ind., resigned to become superintendent of the Carmichael Gravel Co., also of Williamsport.

* * *

The Los Angeles Rock & Gravel Co. was awarded a contract to level Signal Hill at Long Beach, Cal., in preparation for its development as a residential community. Sand and gravel were to be reclaimed in the earth-moving operations while the remainder of the material was to be used for filling a swampy area close to the city.

The Yuba River Sand Co. of Sacramento, Cal., obtained a contract to supply 12,750 tons of sand for county-highway construction. The price was 72 cents per ton.

* * *

Ten Years Ago

THE W. G. Black Co. of Davenport, Ia., took over the Randolph Sand & Gravel Co. of Randolph, Minn. Officers of the company were Fred Black, president; J. A. Burnquist, vice-president; and S. R. McNeal, secretary.

The new plant of the Luckey Lime & Supply Co. at Luckey, O., was pointed out as an outstanding example of the progress being made in the lime industry. Six Arnold kilns 13 ft. 6 in. in diameter and 26 ft. high, above the firing plant, were employed. Capacity was 150 tons of hydrated lime per day.

* * *

Owing to the high freight rates existing at that time, producers of sand, gravel and crushed stone were returning to motor trucks for deliveries of material within a radius of 25 miles.

* * *

Five Years Ago

HERALDED as the largest quarry plant on record in the East, 450,000 tons of stone were brought down at the Middlefield quarry of the Connecticut Quarries Co. at Reeds, Gap, Conn. More than 80,000 lb. of 40-per cent. dynamite was used.

* * *

The Newaygo Portland Cement Co., through J. B. John, president, was reported to have offered $700,000 for the purchase of Michigan's convict-operated cement plant at Chelsea, Mich.

* * *

Announcement was made of the formation of the Higby-Reynolds Silica Co. at Ottawa, Ill., to take over the properties of the Higby Canyon Sand Co. and the E. J. Reynolds Sand Co. Officers of the new concern were: T. V. Taylor, president; A. S. Hindman and H. C. Cary, vice-presidents; C. J. Niesen, secretary; and E. W. Weaver, general manager.

* * *

New incorporations included the following: Chenango Valley Sand & Gravel Co., Sherburn, N. Y., capital $30,000; Patuxent River Sand & Gravel Co., Dover, Del., capital $100,000; West Virginia Cement Co., Wilmington, Del., capital $2,525,000; Long Beach Sand Co., New York, N. Y., capital $200,000.

* * *

K. H. Talbot was appointed manager of cement sales by the Cowham Engineering Co. of Chicago, operating the plants owned by the Consolidated Cement Corp. Mr. Talbot was formerly connected with the Universal Portland Cement Co.

New Corporations

ILLINOIS LIMESTONE & FERTILIZER Co., Gladstone, Ill. $10,000. W. R. Forquer, John A. Miller and W. A. Irons.

BURBANK ROCK PRODUCTS CO., LTD., Los Angeles, Cal. $500,000. R. A. Watson, William Ball and Walter L. Stine.

STATE CENTER MINING CO., Asheboro, N. C. 1,000 sh. n.p.v. J. D. Ross, Ida M. Ross and R. B. Ferree, Asheboro, and Ora Grace Overton, Washington, D. C. Sand and gravel.

MINNESOTA SAND & GRAVEL CO., INC., Minneapolis, Minn. $50,000. C. H. Klein, V. O. Lenmark and Ivar L. Lenmark.

APFIELD RISTAU CONCRETE PRODUCTS CO., 712 E. Empire St., Bloomington, Ill. $27,000. Albert J. and Mrs. Arline J. Ristau, Joseph and Mrs. Vera Apfield.

ARUNDEL-BROOKS CONCRETE CORP., Baltimore, Md. 5,000 sh. n.p.v. Joseph J. Heck, Walter B. Brooks, Jr., and Richard A. Froehlinger.

KEIL STONE & GRAVEL CORP., Hudson, N. Y. $25,000. Gotlieb Keil, 50 Fairview Ave., Hudson, and John Keil and David Keil of the Town of Stockport.

BUILDERS SAND & GRAVEL CORP., Brooklyn, N. Y. 200 sh. common.

WALLINGTON SAND CO., Sodus, N. Y. H. O. Button.

EXTERNAL CONCRETE CORP., Rochester, N. Y. $10,000 preferred and 150 sh. common. H. L. Abt, Buffalo, N. Y.

Vermont Marble Seeking Bids on New Warehouse

The Vermont Marble Co. is soon to take bids on the erection of a warehouse in San Francisco, Cal., to cost about $75,000.

Personal Mention

C. Eugene Ireland, president of the Birmingham Slag Co., has been named vice-chairman of the General Arrangements Committee for the nineteenth annual convention of the United States Good Roads Assn. and the Bankhead National Highway Assn., which meet in Birmingham Oct. 12-13.

Robert H. Miller has organized the Calcined Clay Co. of Missouri and a modern plant is being erected at New Florence, Mo. The company plans to devote its efforts to the production of calcined clay in its natural state. The plant is expected to be in readiness to begin production on September 15. Mr. Miller was formerly connected with the North American Refractories Co.

John S. Bleecker, who has been appointed manager of sales of Lukenweld, Inc. (Division of Lukens Steel Co.), Coatesville, Pa., was graduated from the Massachusetts Institute of Technology in 1898 where he specialized in both mechanical and electrical engineering. He began his career with the American Bell Telephone Co. Most of his activities for the next twenty-seven years—from 1901 to 1928—were confined to executive management of many enterprises for Stone & Webster, Day and Zimmermann & Bates, Inc. From 1928 and until his association with Lukenwald, Inc., in 1931, he was a registered professional engineer engaged in industrial and public utility work, specializing particularly in transportation and merchandising.

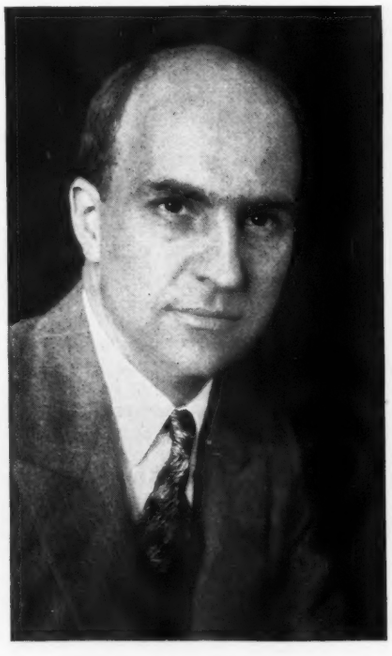
Norman G. Hough, president of the National Lime Assn., recently addressed the Chattanooga Engineers' Club on the importance of the lime industry to the nation.

R. Rex White of 6489 Ross St., Philadelphia, Pa., has been appointed sales representative by Asbestos Corp., Ltd., of Montreal. His territory will be the Philadelphia district.

H. J. Beach was elected president of the Flexible Steel Lacing Co., at a recent meeting of the company's board of directors. Mr. Beach succeeds P. S. Rinaldo who passed away last May. Other officers named were: vice-president, **M. B. Beach;** secretary, **H. L. Coats;** treasurer, **P. S. Rinaldo, Jr.;** assistant secretary, **J. C. Olsen.** Mr. Beach has been active in the company for nineteen years, having occupied executive responsibilities in practically every phase of the business. He, M. B. Beach and P. S. Rinaldo, Jr. are sons of founders of the company. Mr. Coats will continue as director af sales and Mr. Olsen as director of production.

H. E. Chilcoat.

H. E. Chilcoat has been appointed general sales manager of the Koppel Industrial Car & Equipment Co., Koppel, Pa. Mr. Chilcoat was formerly sales manager of the air-dump-car department of that company and has had a long experience in selling materials-handling equipment to the contractor, railroad, industrial and quarry fields.



H. J. Beach.

Obituary

Donald Cashman, 27, met his death Aug. 18 in a crushed-stone quarry at Danville, O., which is operated by his father, John Cashman, Wilmington, O., contractor. Mr. Cashman was cleaning a screen on top of the screening building when he slipped and fell 30 ft. to the ground. He was rushed to a hospital but died enroute. Mr. Cashman was an engineer graduate of Carnegie Tech and besides his widow and parents, is survived by three brothers and one sister.

Joseph Lieurance, an employee in the Laramie, Wyo., cement plant of the Monolith Midwest Co., recently suffered a fractured leg when the member became caught in a clam-shell bucket in the cement-rock quarry.

W. R. Kirkpatrick, head burner at the plant of the Cumberland Portland Cement Co. at Cowan, Tenn., died recently at his home in Cowan. Death followed a severe sunstroke which he had suffered about a week previous.

Harry Fox, president of the Piqua Granite & Marble Co., died at a Covington, O., hospital recently after a short illness. He had been connected with the granite concern for a score of years and had been its president since 1916. He is survived by the widow and two children.

William A. Loutt, 45, employed as an engineer of a switch-engine in the yards of the American Aggregates Corp. at Indianapolis, was killed August 22 when a gravel bin toppled over onto the engine. **James Woodall,** the fireman, and **E. F. Dalton,** brakeman, were only slightly hurt when they leaped to safety. The engine was backing into a side-track to couple a string of cars when the accident occurred. The rear drawbar on the engine struck the foremost car and the jar loosened a chock with which the wheels of the last car were braced. The effort to couple to the cars failed and without the engine to hold them, they started away from it down a slight grade. Mr. Loutt backed the engine against them again and the coupling was made. Before he could stop the engine, however, the weight of the rolling cars drew it under the sand bin. The top of the locomotive cab struck the loading apparatus on the bin, which extended over the track, and the bin fell upon the cab.

Traffic News and Comment

Recent I. C. C. Decisions

Crushed Stone, Sand and Gravel.—The South Carolina Commission on Aug. 24, 1928, prescribed a scale for use in making rates on sand between points in the state for distances up to 480 mi. For distances under 320 mi. this scale was the same as that prescribed by the Interstate Commerce Commission in Docket No. 17,517, Rates on Chert, Clay, Sand and Gravel Within State of Georgia, for single-line application. The South Carolina Commission, however, ordered their scale to be used for making both single- and joint-line rates, and that it should apply over the shortest route over which car-load traffic could move without transfer of lading, and refused to provide any differentials for the short or weak lines. The Atlantic Coast Line, Seaboard Air Line, Southern and ten short lines petitioned the federal commission to determine the quality of the rates maintained by them, published on the order of the South Carolina Commission. The commission found the rates maintained by the respondents, for application within the state of South Carolina, generally to be unduly prejudicial to interstate shippers, unduly preferential of intrastate shippers, and unjustly discriminatory against interstate commerce to the extent that these rates were lower than would be made by application of the scale prescribed in I. C. C. Docket No. 17,517. This decision prescribed both single and joint scales and arbitraries for short and weak lines. New rates are to be made effective not later than Oct. 12. I. C. C. Docket No. 22,-109, Rates on Sand, Gravel, Crushed Stone, etc., Within the State of South Carolina.

Sand.—Reparation has been awarded on a finding that the rate on sand from Gladstone, Ill., to Keokuk, Ia., was unreasonable but not unduly prejudicial to the extent it exceeded 85 c. a net ton. I. C. C. Docket No. 23,726, Cameron, Joyce, Smith, Elder Co. *v.* C. B. & Q.

Sand and Gravel.—The commission has awarded reparation on a finding that the rates on sand and gravel from La Grange, Mo., to Industry and Littleton, Ill., were unreasonable to the extent that the factor thereof to Macomb, Ill., exceeded 79 c. a net ton and the factors beyond Macomb exceeded 42 c. I. C. C. Docket No. 22,-420, Missouri Gravel Co. *v.* C. B. & Q. *et al.*

Soapstone.—The commission has found applicable and not unreasonable the rate on rough soapstone from Joliet, Ill., to Saginaw, Mich., and has dismissed the complaint in I. C. C. Docket No. 23,773, United States Graphite Co. *v.* M. C.

Sulphur.—The commission has found that the rate on crude sulphur from Hoskins, Tex., to Cloquet, Minn., was not unreasonable or otherwise unlawful, and has dismissed the complaint in I. C. C. Docket No. 23,300, Northwest Paper Co. *v.* B. S. L. & W. *et al.*

Fourth-Section Relief

Lime.—Relief from the long- and short-haul clause of the fourth section in the establishment of rates on lime from Watauga, Tenn., Leeds, North Birmingham and Phoenixville, Ala., to destinations in Southern territory named in Agent Glenn's I. C. C. A-684, has been granted subject to the usual restrictions as to circuity, in response to Tilford's application No. 14,376. Rates from Watauga, Tenn., are to be the same as the present rates in effect on like traffic from Elkanah, Tenn., to the same destinations. Rates from Leeds, North Birmingham and Phoenixville, Ala., to destinations over 100 mi. from these origin points are to be the same as the present rates from the Alabama group to the same destinations. Included in the Alabama group are, Graystone, Pelham, Keystone, Wilmay, Saginaw, Landmark, Longview, Varnons, Calera, Newala and Roberta, Ala. F. S. O. No. 10,677.

Fourth-Section Applications

Crushed Stone and Asphalt Rock.—Agent Leland has requested fourth-section relief in connection with the establishment of rates on asphalt rock and stone, crushed or ground, from Texas producing points to destinations in Arkansas, Kansas, Louisiana, Missouri, and Oklahoma, and on limestone, broken, crushed or ground, from Margerum and Cherokee, Ala., to points in Arkansas, Kansas, Louisiana, Missouri Oklahoma and Texas. F. S. Appl. No. 14,460.

New Complaints Filed

Cement.—A rate in violation of Sec. 1 and 3 on cement from Speed, Ind., to Brixment, N. Y., as compared with rates in the same general territory, and from producing points in C. F. A. territory and from Kosmosdale, Ky., to New York points is charged, and a lawful rate and reparation sought in I. C. C. Docket No. 24,599, Louisville Cement Co., Louisville, Ky. *v.* C. C. C. & St. L. *et al.*

Crushed Stone.—Rates and charges in violation of Sec. 1 and 6 on crushed limestone from Krause, Ill., to Cape-ville, Tenn., is charged and protection of legal rate and refund asked in I. C. C. Docket No. 24,606, Shelby County Commissioners, Memphis, Tenn. *v.* Mo. Pac. *et al.*

Complainant asks the commission to find the rates on crushed or broken stone from Westfield, Mass., to White Plains, N. Y., unreasonable and unduly preferential of shippers at Branford, Rocky Hill and New Britain, Conn., and to award reparation in I. C. C. Docket No. 24,618, John S. Lane & Son, Inc., Meriden, Conn. *v.* N. Y. N. H. & H. *et al.*

Crushed Stone and Other Road-Building Materials.—Rates in violation of Sec. 1, 3 and 13 on crushed stone and other road-building materials from Walford, Pa., to points in Pennsylvania, West Virginia and Ohio, are alleged, competitors in Ohio, western Pennsylvania, and West Virginia being preferred. New rates are sought. I. C. C. Docket No. 24,597, Bessemer Limestone & Cement Co., Youngstown, O. *v.* A. & B. B. *et al.*

Lime.—Unreasonable rates and charges on lime from Mosher, Mo., to Charleston, S. C., are the basis for a complaint in which reparation is sought. I. C. C. Docket No. 24,595, Phosphate Products Corp., Richmond, Va. *v.* Mo.-Ill. *et al.*

Talc.—Unreasonable rate in violation of Sec. 4 is alleged and reparation is sought on shipment of crude ground talc from Emeryville, N. Y., to Lynchburg, Va. I. C. C. Docket No. 24,587, Traffic Bureau, Lynchburg (Va.) Chamber of Commerce for Thornhill Wagon Co. *v.* C. & O. *et al.*

Rate-Committee Dockets

New England Freight Assn.

Crushed Stone.—To meet motor-truck competition shippers propose a reduction in the rate on crushed stone,[1] from West Quincy, Mass., to Needham, Mass., from 90 to 50 c. a net ton. Docket No. 23,206.

Trunk Line Assn.

Feldspar.—Carriers propose to publish the following rates per 100 lb. on feldspar and quartzite, in packages or in bulk, car-load minimum weight 60,-000 lb., from Indian and Wanup, Ont., to Rochester, N. Y., 21 c.; Trenton, N. J., 38½ c.; Wheeling, W. Va., 40 c.; Buffalo, N. Y., 27½ c.; Newark, N. J., 38½ c., and New York, N. Y., 38½ c. Docket No. 27,452.

Sand.—To meet motor-truck competition shippers propose a rate on sand[1] from Kenvil and Hopatcong Jct., N. J., to Plainfield, N. J., of 70 c. a net ton. Docket No. 27,470.

Sand and Gravel.—To meet motor-truck competition shippers at Boonville, N. Y., propose the following re-

duced rates on common sand and gravel [1] to destinations in New York, to expire Dec. 31, 1931. To Prospect Jct., 65 c.; Trenton Chasm, 65 c.; Gravesville, 65 c.; Poland, 65 c.; Newport, 65 c.; Middleville, 65 c.; County Home, 65 c.; Kast Bridge, 75 c., and Herkimer, 75 c. a net ton. Docket No. 27,453.

To meet motor-truck competition shippers propose a rate of 50 c. a net ton on common sand and gravel [1] from Farmingdale, N. J., to Oceanport, N. J. Docket No. 27,462.

To meet motor-truck competition shippers propose a rate on sand and gravel [1] from Farmingdale, N. J., to Lakehurst, N. J., of 60 c. a net ton, to expire April 30, 1932. Docket No. 27,469.

Central Freight Assn.

Crushed Stone.—Shippers at Bascom, O., are proposing reductions in the rates on crushed stone [1] to four Ohio destinations as shown below. The column headed, "P.S.M. 923," gives the rates which would be made by the use of the scale shown in the proceedings of special meeting No. 923, Central Freight Assn. Docket No. 29,098.

To	Miles	Present	Proposed	P.S.M. 923
Willard, O.	28	$0.60	$0.50	$0.70
Sullivan, O. ...	56	.80	.70	.90
Cleveland, O. ..	124	.90	.80	1.15
New Haven, O.	31	.60	.50	.75

Grinding Sand.—Shippers of grinding sand propose a reduction in the rate on that commodity [1] from Muskegon, Mich., to Rossford, Ohio, from $1.26 to $1.01 a net ton. Docket No. 29,141.

Sand and Gravel.—Shippers propose a reduction in the rate on sand and gravel in open-top cars, from Sargents, O., to Pedro, O., from 90 to 70 c. a net ton, to apply via N. & W., Ironton, O., D. T. & I., and to expire Dec. 31, 1931. Docket No. 29,113.

Slag.—A reduction in the rating on granulated or lump slag, in bulk or in bags, in box-cars, car-load minimum weight 50,000 lb., from points in Central Freight Assn. territory to points in Canada, is being sought by shippers. They propose a rating of 83.33 per cent. of sixth class. The present basis is sixth class with a car-load minimum weight of 40,000 lb. Docket No. 29,132.

Southwestern Freight Bureau

Lime.—Shippers request the establishment of a rate of 16 c. per 100 lb., on ground lime in bulk, car-load minimum weight 50,000 lb., from Mosher and Ste. Genevieve, Mo., to Tulsa, Okla. The rate from Ash Grove-Springfield Group is 11½ c. and the rate from Limedale Spur and Ruddells is 13 c. on ground lime, car-load minimum weight 50,000 lb., while on common lime the rates are 21 and 22½ c. respectively, with a minimum weight of 30,000 lb. Proponent shippers are unable to compete for the Tulsa business on the basis of the present rates and request rates reflecting the same relationship that exists from competing points. Docket No. 23,388.

Plaster.—Carriers propose to adjust the rates on plaster and related articles, description and minimum weight as per S.W.L. Tariff 3-1, from Texas and Oklahoma producing points to stations in Minnesota and Iowa on the M. & St. L., C. & N. W., C. St. P. M. & O., and the C. M. St. P. & P., so as to place these roads on a parity with the other lines. A few of the proposed rates are shown below. Complete exhibit will be furnished on shippers' request. Docket No. 23,381.

To	Proposed
St. Paul, Minn.	30½c.
Waterville, Minn.	30½c.
Ft. Dodge, Ia.	30½c.
Des Moines, Ia.	30½c.
Mason City, Ia.	30½c.
Marshalltown, Ia	26½c.
Martinsburg, Ia.	26½c.
Morning Sun, Ia.	26½c.
Winona, Minn.	30½c.
Mankato, Minn.	30½c.

[1] The car-load minimum weight will be 90 per cent. of the marked capacity of the car except that, when the car is loaded to full cubical or visible capacity, the actual weight will apply

Correspondence

Another Apt Example of Government in Business

To the Editor:

It seems that no one has been able to get any information on the cost of producing the material produced by the state quarry in this section of Iowa, but as a quarryman I would say it is costing them from $2 to $3 per cu. yd. to get this material out. I know of one job in particular which was let within the last 30 days, where the state quarry price was 70c. per cu. yd. This figure is considerably lower than our cost price and they have been selling riprap at 50c. per cu. yd. The state sells this material at these figures to an individual concern in Des Moines, and they resell it and make from 20 to 30c. per ton on the open market.

Keokuk, Ia. PRODUCER.

Silicosis Established as an Occupational Hazard

To the Editor:

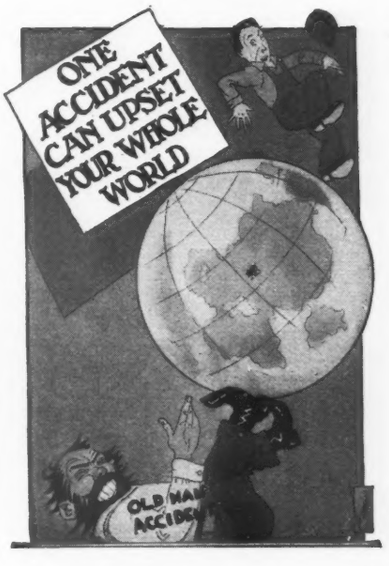
As you are doubtless aware, a number of claims on account of death or disability due to silicosis have been filed against several manufacturers in this state. I am advised that a few such claims have been settled by agreement out of court. In addition, action brought by one claimant against the New Jersey Pulverizing Co. resulted in a verdict for $3,000 in the Supreme Court of this state. A similar action in the Federal District Court against the Pennsylvania Pulverizing Co. and/or Pennsylvania Glass Sand Co. has produced a $10,000 verdict. Both these cases are regarded in the nature of tests and it seems as though the matter must remain largely in abeyance until the appeal actions have been determined.

Meanwhile, it has been established with considerable assurance that there is an occupational hazard due, upon more or less accurate diagnosis, to silicosis, for which the employer may be held liable and the claims for which his insurance carrier must defend and indemnify. Consequently, upon the most recent revision of premium rates for workmen's compensation and employer's liability insurance in this state effective July 1, 1931, it has been found necessary to increase the rate for the employer's obligation under the common-law. Consequently, the premium rates in force at this time for silica grinding, manual code No. 1741, is $4.90 per $100 of pay-roll for complete coverage of the liability under the compensation act and for any other personal injuries for which the employer may be liable at common-law, and 20 per cent. of this rate has been allocated specifically to the occupational hazards of silicosis, which are outside the scope of the Compensation Act of New Jersey.

COMPENSATION RATING AND INSPECTION BUREAU OF NEW JERSEY
A. R. Lawrence, *Chairman.*
Newark, N. J.

Road-Machinery Co. Takes Over Rubert M. Gay Co.

The Universal Road Machinery Co. of Kingston, N. Y., has acquired the Rubert M. Gay Co. of 114 Liberty St., New York, N. Y., following the death of Rubert M. Gay which occurred August 4 of this year. The Gay organization will be known in the future as the Rubert M. Gay Co.—Division of the Universal Road Machinery Co. Offices at 114 Liberty St. and laboratories at 27 Thames St. will continue to be maintained.



Financial News

The information contained in these financial pages is given with the understanding that any statement on the part of this magazine or any of its staff, as to the responsibility or standing of any person, firm or corporation, or as to the value of any property or securities is a mere expression of opinion, given as a matter of service to the readers of PIT AND QUARRY, *for which no responsibility in any way is to attach to this magazine or to any of its staff.*

Indiana Limestone Has Deficit in Six Months

Indiana Limestone Co. reports for six months ended May 31, 1931, net loss of $876,498 after interest, depreciation and depletion. No comparison is available. Operating loss before interest, depreciation and depletion, was $64,002, against operating profit of $1,025,925 in first six months of previous fiscal year. Net sales amounted to $2,836,956, comparing with $5,438,336 in corresponding period of 1930.

Commenting on the outlook for dimension limestone, A. E. Dickinson, president, said:

"The building outlook has more promise than at any time in the past year. Fall will see on our estimating tables a large volume of work scheduled for early inauguration. Important contracts will be closed within 30 days, while contracts recently closed by us include the Marshall Field Building in Chicago and the Federal Building in Kansas City.

"Our unfilled orders on January 1, next, will be far ahead of the total on January 1, 1931."

Raybestos Net 86 Cents Per Share in Half Year

Raybestos-Manhattan, Inc., reports for six months ended June 30, 1931, consolidated net income of $580,179, after depreciation, federal taxes, adjustment of inventories, etc., equivalent to 86 cents a share on 676,012 shares of no-par common stock. This compares with $825,499, or $1.22 a share on 675,007 shares, in the first half of 1930.

For the quarter ended June 30, 1931, consolidated net income was $338,976, after taxes and charges, equal to 50 cents a share on 676,012 shares, comparing with $241,203, or 35 cents a share in preceding quarter, and $374,524, or 55 cents a share on 675,007 shares in the June quarter of preceding year.

Operations in the second quarter showed a substantial improvement over the first quarter of the year, while business in August was in advance of July, which in turn exceeded June. Similarly, net earnings of 86 cents a share in the first half of the year compared with net profits of 49 cents a share in the last half of 1930.

Cash and marketable securities on hand as of July 31 totaled $3,355,000 compared with $3,221,000 on December 31, 1930. Current assets at the end of July totaled $8,266,000 and current liabilities were $553,000, or a ratio of 15 to 1. Of the current liabilities, $91,000 represented reserve for Federal taxes and $90,000 represented accrued wages and salaries.

The company has declared the quarterly dividend of 40 cents, payable September 15 to stock of record August 31.

North American Cement Reports $210,997 Loss

North American Cement Corp. reports for the six months ended June 30, 1931, net loss of $210,997 after taxes, depreciation, depletion, interest, etc., comparing with a net loss of $49,374 in the first half of 1930.

Consolidated Rock Plan Will Improve Position

A program for improving the position of the stockholders of the Consolidated Rock Products Co. of Los Angeles, promised in the annual report of the company submitted February 18 has been prepared by the management and received the approval of the board of directors at the August meeting in Los Angeles.

The program calls for a readjustment of property values on the basis of present utility values and the reduction of stated capital of the company in accordance therewith. This move eliminates excessive charges for depreciation required under the original property values set up at the time of the organization of the company in January, 1929, thereby making it possible to create a surplus more quickly for dividend payments on the basis of current earnings.

Oppose Proposal to Sell Prison-Made Agstone

An injunction attacking the constitutionality of an act passed by the Illinois legislature on July 3 providing for the free distribution to farmers of agricultural limestone made by convict labor at the Chester state penitentiary was filed August 11 at Springfield by several producers. Those who united in taking the action were the Columbia Quarry Co., St. Louis, Mo.; Illinois Electric Limestone Co., St. Louis, Mo.; Mississippi Lime & Material Co., Alton, Ill.; Ohio & Indiana Stone Co., Indianapolis, Ind.; Casper Stolle Quarry & Contracting Co., East St. Louis, Ill.; and the Charles Stone Co. of Mt. Vernon, Ill.

The firms set forth that they are engaged in producing agricultural limestone and that administration of the law is injurious to them. They contend that the law violates a provision of the state constitution forbidding the state from granting special privileges to firms or individuals, and also a provision forbidding the state from assuming debts or liabilities of, or to loan or extend credit to an association or individual.

Gravel Company Sues to Enjoin Lease of Deposit

The Western Sand & Gravel Co. of Spring Valley, Ill., has instituted court proceedings to enjoin the city of Spring Valley from leasing gravel deposits to Chicago interests, claiming it had received unfair treatment on its own proposal to lease the municipal lands.

The deposit in question, which adjoins the property of the Western Sand & Gravel Co., was leased to James E. Casey of Chicago for five years at $150 per year, while Glenn N. Sitterly, vice-president of the Western company, claims the Spring Valley city council refused his company a lease for a five-year period at $200 per year. Both proposals agreed that the municipality would be allowed 1,000 cu. yd. of gravel each year without charge.

CURRENT DIVIDENDS

Company	Class of Stock	Dividend Rate	Holders of Record	Payable	Company	Class of Stock	Dividend Rate	Holders of Record	Payable
Bessemer Limestone & Cement	Class A	$0.50 qr.	July 20	Aug. 1	Johns-Manville	Common	$0.75 qr.	.....	Oct. 15
Canada Dredge and Dock	Common	.....	July 16	Aug. 1	Johns-Manville	Preferred	$1.75 qr.	.....	Oct. 1
Canada Dredge and Dock	Preferred	.....	July 16	Aug. 1	National Gypsum Co	Preferred	$1.75 qr.	Sept. 15	Oct. 1
Cleveland Quarries	Common	$0.75 qr.	Aug. 15	Sept. 1	Raybestos-Manhattan	Common	$0.40 qr.	Aug. 31	Sept. 15
Consolidated Sand & Gravel	Preferred	$1.75 qr.	.....	Aug. 15	Riverside Cement	1st Pfd.	$1.50 qr.	July 15	Aug. 1
Construction Materials	Preferred	$0.87½ qr.	.....	Aug. 1	Standard Paving & Material	Preferred	$1.75 qr.	.....	Aug. 15
General Asphalt	Common	$0.50 qr.	Sept. 1	Sept. 15	Superior Portland Cement	Class A	$0.27½M	Aug. 23	Sept. 1
Great Lakes Dredge & Dock	Common	$0.25 qr.	Aug. 5	Aug. 15	Texas Gulf Sulphur	Common	$0.75 qr.	Sept. 1	Sept. 15

Review of Foreign Practice

Three Types of Cement Manufactured in Poland

Three different types of commercial cements are produced by the factories of Poland: (1) standard Portland cement meeting the specifications prescribed by the "Polish Normalization Commission"; (2) "super" Portland cement used in special works, having a compressive strength at 3 days of 250 kg. per sq. cm. and at 28 days of 500 kg. per sq. cm.; this cement is manufactured on order and is considerably more expensive than the regular Portland; and (3) "Siccofix," a Portland cement treated to make it impermeable. In the near future another special cement, a rapid-hardening cement made according to the patents of Prof. Kühl of Berlin, will be put on the market. Its price will be about 30 per cent. higher than that of the regular Portland.—*Revues des Materiaux de Construction* No. 262, pp. 305-6, July, 1931.

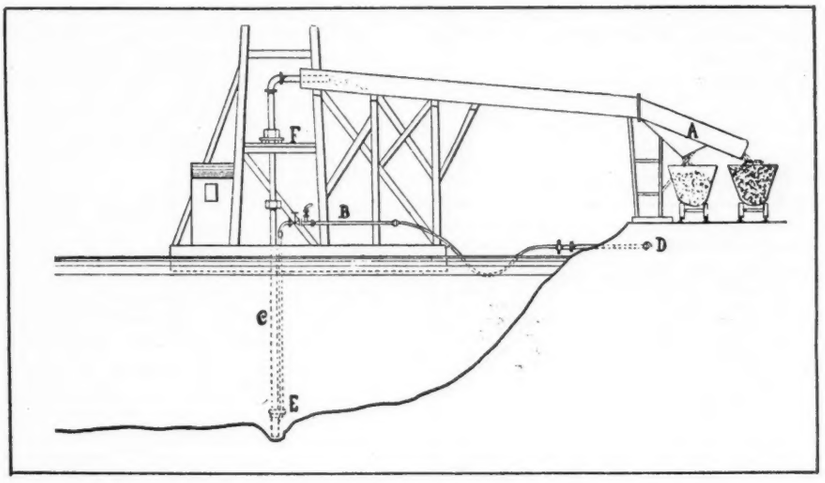
Mammoth Pump Lifts Sand to Brick Operation

Although most German sand-lime-brick plants which produce their own sand excavate with bucket-type excavators, there are two which dig to a depth of 8 meters by means of what are called "mammoth" pumps, operated by compressed air. These plants were developed by Leo Thierbach at Ziegelberg, East Prussia, and C. Holzrichter at Greifenberg, Pomerania. This type of pump consists of an appropriate casing supported on a floating structure and fed by compressors that are usually located on the bank and connected with the pump by means of piping with at least one flexible unit. The compressed air is introduced at the bottom of the casing (at *E* in the drawing), and because of its force creates a mixture of air, sand and water, which is lighter than the water around and above it, and hence is forced up through the casing. A depth of at least 4 meters is required to produce the necessary pressure, but if this is not naturally available a hole can be dug for the start of operations. The drawing shows a typical simple operation for loading the pumped sand into cars for haulage to the sand-lime-brick plant.—*Tonindustrie-Zeitung* 55:725, June 22, 1931.

Sand-Lime-Brick Plant Noted for Architecture

The sand-lime-brick factory of the Hartsteinwerk Niedersachsen G. m. b. H., Hannover, near Garbsen, was built in 1928 according to the design of Dipl.-Ing. L. Thiele, chosen in a competition among Hannover architects, and has attracted wide attention for its architectural attractiveness. It was equipped by the Maschinenfabrik Komnick of Elbing, and operates by the hydrator-mixer process; it has at present three rotary brick-presses with an hourly capacity of 2,500 bricks apiece, and provision has been made for increasing capacity by the installation of an additional press and a second mixer.

Lump lime is crushed, then ground in a ball-mill, and elevated to an air-separator feeding a raw-lime bin. From this bin the lime passes through an automatic weighing device and screw-conveyor to the hydrator-mixer, a barrel conical at each end, where it is hydrated and mixed with sand. The resulting mix is dropped to a large bin, from which it is fed to an elevator and lifted to a drag-conveyor that feeds it to the hoppers over the presses. The bricks from the presses pass to five hardening kettles, each 18 m. (about 59 ft.) long and 2 m. (about 6½ ft.) in diameter. Four of these kettles require 8 hr. for the hardening of the bricks, but the fifth, operating by a special process, requires only 4 hr. By means of a special handling device the bricks can be swung direct from the cars to motor trucks as the cars leave the kettles. The plant building contains, besides the factory itself, an office, a workshop, and lunch-, dressing- and bathrooms for the workers.—*Tonindustrie-Zeitung* 55:721-2, June 22, 1931.



Simple installation of the "mammoth" pump.

Gypsum-Calcining Plant in France Is Described

A new gypsum mining-and-quarrying plant has recently been built at Fitou, Aude, for the Société Nouvelle des Platres de Fitou, of Albi. The rock is mined in galleries from a Permian deposit about 4 km. (about 2½ mi.) from the plant, which is situated along the railway line from Narbonne to Perpignan. The rock is conveyed out of the mine by means of an incline to loading hoppers, and is carried by a tramway to the calcining plant. There the rock goes through a crusher and then a hammer-mill, and the ground gypsum is passed through a rotary sizing screen. From this screen the "fines" can be sent to the packing plant for agricultural gypsum and the coarse for sale to cement plants, or the coarse can be chuted to a second hammer-mill and all gypsum conveyed to the calcining plant.

The ground gypsum for calcining is first dried in a rotary cylinder heated to 115 to 125 deg. C. by the waste-heat gases from the kettles. In this drier the gypsum passes through the first swelling, thus aiding the work of the kettles, and, if required, can be sacked immediately for sale to fertilizer manufacturers. The remainder is conveyed to four kettles, each having a capacity of 25 metric tons of plaster in 24 hr. The plaster discharged from the kettles is carried by chain drag-conveyors to an apparatus which stores it in bins, from which it is reclaimed to the bagging plant and packed for shipment either by trucks or by rail.

The plant is also equipped with an air-separation apparatus in conjunction with a grinding mill which makes it possible to produce extremely fine plaster, or to mix fine plaster with the regular plaster, making a product of very high strength. The operation of the plant is automatic throughout.—J. E. Duchez in *Revue des Materiaux de Construction* No. 262, pp. 274-5, July, 1931.

Recent Patents

AMERICAN

Cement and Concrete

Automatic cement-packing machine. William R. Peterson, Chicago, Ill., assignor to Bates Valve Bag Corp., same place. No. 1,818,091.

Cellular concrete machine. Harry E. Brookby, Evanston, Ill., and Fred J. Gough, Fort Dodge, Ia., assignors to United States Gypsum Co., Chicago, Ill. No. 1,818,376.

Conveying

Shaker conveyor. Tage G. Nyborg, Worcester, England. No. 1,817,927.

Crushing and Grinding

Hammer mill. John Mursch, Kenmore, N. Y., assignor to Buffalo Hammer Mill Corp., same place. No. 1,818,570.

Excavating

Excavating machinery. William M. Bager and Werner Lehman, South Milwaukee, Wis., assignors to Bucyrus-Erie Co., same place. No. 1,817,905.

Excavating and conveying apparatus. William H. Dance, Cambridge, Mass. No. 1,817,971.

Excavating machinery. Paul S. Stevens, South Milwaukee, Wis., assignor to Bucyrus-Erie Co., same place. No. 1,818,106.

FOREIGN

Blasting

Heating-compositions for blasting-cartridges. D. Hoge and W. Eschbach. British 348,657.

Device for regulating the time interval in extinguishing the flame in blasting. Emil Witte, Bunzlau. German 531,270.

Cement and Concrete

Plastic cements. J. Schoeller. French 703,437.

Process for burning cement and similar materials. Metallgesellschaft (Akt.-Ges.). French 705,586.

Process for making cement impermeable. Chemische Fabrik Grunau, Landshorff & Meyer Akt.-Ges. French 705,920.

Process for the production of white cement from colored raw materials, e. g., iron-bearing. "Miag" Muhlenbau and Industrie Akt.-Ges., Frankfurt a. M. German 531,416.

Crushing and Grinding

Hammers for centrifugal crushing-mills. G. P. Lucas. British 348,736.

Jaw crushers. Nordberg Manufacturing Co. British 348,851.

Grinding or pulverizing machines. Buckley & Taylor, Ltd., and T. Buckley. British 349,516.

Granulator. Esch-Werke Kom.-Ges., Maschinenfabrik und Eisengiesserei, Duisburg-Hochfeld. German 531,442.

Hammer mill. C. Franticek Loos, Brno, Czechoslovakia. German 531,444.

Spring-roller mill. Alfred Oskar Schulze, Hamburg. German 531,564.

Drilling

Well-drilling apparatus. W. A. Loomis. British 348,561.

Drilling-jigs. Kings Patent Agency, Ltd. (J. Gordon). British 348,730.

Rock-drill blowing device. The Ingersoll-Rand Co., New York, N. Y., assignee of William Augustus Smith, Sr., and John Clark Curtis, Easton, Pa. Canadian 314,229.

Drying

Drying and cooling apparatus. W. Dryden. British 348,558.

Machines or apparatus for drying sand. H. Bros-Combe and A. F. Kellett. British 349,308.

Drying plant. N. Panzireff. British 349,583.

Shaft drier for salt and similar granular materials. Charles Moore & Co., Ltd., William Morris Shaw and William Tranton, Liverpool, England. German 530,977.

Rotary drier. Dr. Ernst Froehlich, Vienna. German 531,570.

Excavating

Dredges. L. Mellersh-Jackson (Yuba Manufacturing Co.). British 349,369.

Stripping machine. A. T. G. Allgemeine Transportanlagen-Gesellschaft m. b. H., Leipzig. German 531,418.

Gypsum

Improvements in the manufacture of plasters. V. Lefebure. French 703,528.

Addition to patent taken Aug. 6, 1929, for improvements in kilns for the burning of gypsum and similar materials. Mussat, Binot et Co. French 38,445-679,934.

Anhydrite or gypsum cementing compositions. P. P. Budnikoff. British 348,766.

Kilns

Rotary kiln. Societe Etablissements Susset. French 705,222.

Process and apparatus for feeding materials to rotary kilns. A. Busch. British 348,799.

Reducing dust losses from shaft furnaces. G. Eichenberg and N. Wark. British 349,092 and 349,093.

Material-Handling

Pneumatic conveying systems. Akt.-Ges. J. J. Rieter et Cie. British 348,808.

Shaker conveyors. T. G. Nyborg and M. F. Higgins. British 348,863.

Mechanical shovels for shoveling loose materials. Bamag-Meguin Akt.-Ges. British 348,882.

Locking device for connecting together jigging-conveyor pans. L. F. Gerdetz. British 348,953.

Endless-chain conveyors. J. S. Da-Costa. British 349,078.

Conveyors. J. S. Da Costa. British 349,079.

Conveyors. W. H. Barker and W. Bennett. British 349,225.

Shaker conveyors. T. G. Nyborg and M. F. Higgins. British 349,341.

Dump cars. M. F. Edwards. British 349,398.

Grab for bulk materials. Naamlooze Vennootschap Havenbedrijf Vlaardingen-Oost. British 349,571.

Devices for cleaning conveyor belts and the like. Spencer (Melksham), Ltd., and W. L. Philip. British 349,649.

Self-discharging hopper cars. G. Talbot et Cie. British 349,832.

Shaking-trough conveyor. Fried. Krupp Akt.-Ges., Essen. German 531,040.

Feeder for conveyors. Bamag-Meguin Akt.-Ges., Berlin. German 541,463.

Connecting member for shaking conveyors. Dipl.-Ing. Rudolf Goetze, Bochum. German 541,464.

Apparatus for pneumatic conveyors. Firma G. Mattick, Pulznitz i. Sa. German 531,465.

Apparatus for removal of bulk materials. Carlshutte Akt.-Ges. für Eisengiesserei und Maschinenbau, Waldenburg-Altwasser. German 531,609.

Conveyor weighing apparatus. John Chatillon & Sons, New York City, assignee of Edwin Henry Messiter, Jersey City, N. J. Canadian 314,209.

Mixing

Mixing-machines. J. S. Withers (Koehring Co.). British 348,837.

Mixing-machine. J. S. Withers (Koehring Co.). British 349,723.

Mixing-drum. Carl Rein, Hanover. German 530,962.

Water-measuring device, particularly for concrete mixers. Karl Peschke, Maschinenfabrik, Zweibrucken i. d. Rheinpfalz. German 531,255.

Concrete mixer. Gebhard Jaeger, Columbus, Ohio. German 531,542.

Sacking

Paper or like packages or bag constructions. E. S. & A. Robinson, Ltd., and A. Bishop. British 348,592.

Automatic weighing and sacking machine. Alphonse Pasquier, Neuilly-sur-Seine, France. German 531,329.

Screening and Separating

Wire mesh and method of making same. Gilbey Wire Co. British 348-771.

Centrifugal machines for the separation of materials. H. Kammerl. British 348,806.

(Continued on page 79)

PIT AND QUARRY *will furnish, at its actual cost, a copy of any patent cited here. A charge of ten cents per copy is made by the U. S. Patent Office, Washington, D. C., and readers may procure a copy directly by addressing the Commissioner of Patents, with payment for copies requested. Postage stamps are not accepted by the Patent Office. We will endeavor to obtain copies of foreign patents for our readers but we cannot give assurance in every case for the reason that copies of such patents are not printed for distribution as liberally as are the American copies, nor is there a fixed charge per copy.*

Legal Information for Operators

On the Subject of Liens

ALMOST all states have enacted laws which relieve debtors from paying their debts after these have been in existence for a specified period of time. Moreover, it is important to know that the limitation of time specified in state laws is automatically extended if the debtor performs either one of or all the three following things: (1) If he pays any portion of the debt; (2) If he promises absolutely, or makes a new promise, to pay the debt; (3) If a new law is enacted at any time which reduces the limitation. However, the new promise must be absolute, otherwise the debt is not renewed. This important point of the law was decided in the recent case of MacLaren *v.* Gilbert, 295 Pac. 349.

In this case it was disclosed that a contractor purchased nonmetallic building materials for an owner and paid for them. The state law requires debtors to pay their debts within two years, otherwise they are relieved from payment. The owner failed to pay the contractor within the specified two years but, in response to a telegram sent by the contractor asking when payment would be arranged he said:

"I am sorry there is no immediate way of an adjustment of our affairs and you may depend upon me at the first opportunity."

In holding the telegram not an absolute promise to pay the money and that the debt was not renewed, the court said:

"In this language there is no modification or retraction of defendant's (owner's) previous refusal to admit the correctness of the items claimed. Where there is an admission that something is due without specifying how much, there is no account stated. The amount due must be specified or there must be a reference to something by which the amount due can be definitely and certainly ascertained."

Lien Statement Improperly Filed

A material man's lien is altogether statutory, and, when the lawmaking body prescribes the terms upon which it must be asserted, it is beyond the power of a court to waive its provisions or substitute others. Therefore, although by ordinary rules a seller of nonmetallic materials is entitled to a lien for materials furnished, yet the lien will be denied if he fails properly to file the statement or claim.

For instance, in McDonnell *v.* Amo, 34 S. W. (2d) 212, it was disclosed that a material man began furnishing material for the construction of a building. Several days later the owner mortgaged the property and the mortgage was properly recorded. In subsequent litigation the lower court held the material man's lien superior to the mortgage. However, the higher court refused to uphold the validity of the lien because the material man had failed to have verified, in accordance with a state law, his statement filed with the lien claim. This court said:

"The statutes generally require a person desiring to assert a mechanic's lien to file and have recorded, in a designated place and at or within a designated time, an instrument showing that a lien on certain property is claimed by him, and containing certain statements concerning his claim and the property against which he seeks to enforce it. This instrument is variously termed a 'claim,' 'notice,' 'statement,' an 'account,' or an 'affidavit,' according to the phraseology employed in the statutes of different jurisdictions. The filing of the instrument is necessary to establish, perfect, preserve, and enforce the lien."

When Leased Property Is Subject of Lien

Generally speaking, leased property is not subject to a lien unless it is conclusively shown that the owner consented to the improvements or the lease contract contained a clause by which the owner permitted the lessee to make improvements. Also, the contract must be recorded or the owner notified before the building materials are supplied, otherwise the material man is not entitled to a lien. So held the higher Court in Hawkins *v.* Faubel, 31 S. W. (2d) 401.

In this case it was disclosed that, under a lease-contract, an owner consented to the tenant making necessary improvements. The tenant made a contract for improvements but the owner was not notified. All the materials were furnished before Oct. 20 and the lease was recorded Oct. 29. The tenant refused to pay for the materials and a mechanic's lien was filed. In holding the lien void the court said:

"We hold that the owner does not make his property subject to lien merely by consenting for the lessee to make improvements. This view also accords with the general rule where there is no statute making the owner liable who merely consents that the improvement shall be made."

Cost of Preparing Materials Not Subject of Lien

It is important to know that the fact that a material man performs labor or furnishes material for the construction of a building does not entitle him to a mechanic's lien for "labor and materials." For example, in Cook *v.* Corporation, 147 Atl. 891, it was disclosed that a material man attempted to include in a lien the cost of labor performed in preparing the material for use before it was hauled to the job. The court refused to hold the lien valid with respect to the cost of preparing the materials, stating the following important law:

"If the labor is incidental to the manufacture of the article to be sold as a finished product, it becomes indistinguishable in the finished material and, for the purpose of a claim of mechanic's lien for materials, loses its character as labor."

Lien Fails Accurately to Describe Property

It is well-settled law that a court will not hold a mechanic's lien void on mere technicalities. On the other hand, the description of the property with an affidavit filed, in which a mechanic's lien is claimed, must be sufficiently accurate to enable a person familiar with the location to identify the property by reference to the description. If the description is not accurate to that extent the lien is void. So held the higher court in Velten *v.* McDonald, 234 N. W. 23.

The facts of this case are that a contractor and an owner entered into a contract, by the terms of which the former agreed to construct a concrete building. After the building was completed controversy arose over payment and the contractor filed an affidavit claiming a mechanic's lien. In the affidavit the property was described as follows: "Lots 10, 11 and the south half of lot 12." On the tract of land described there were situated five other buildings besides the one erected by the contractor. Since the contractor claimed a lien on but one of the several buildings located on this tract of land, the higher court held the lien void, and said:

"We do not think the description contained in plaintiff's claim of lien is sufficient to identify the premises with reasonable certainty. Plaintiff (contractor) claims a lien on but a single one of these buildings, but there is nothing in his description to indicate which of the six buildings he claims or that would aid a person in identifying the building on which he claims to have a lien."

Gypsum-Block Producer Doubles Plant Capacity

The Berry Building Blocks, Inc., Seattle, Wash., has practically doubled the capacity of its plant, bringing maximum production up to 4,500 sq. ft. per day. On account of the recent retirement of a competing plant this is now the only firm producing gypsum partition tile in Washington.

Manufacturers' Publications

Each publication listed below contains information of interest to nonmetallic mineral producers. Readers may obtain, without charge—except where a price may be stated—and without obligation, copies of any of these publications by writing directly to the manufacturers who publish them. Please mention PIT AND QUARRY *when writing.*

Bins

Blaw-Knox Steel Storage Bins. 36 p. (Cat. No. 1302. Blaw-Knox Co., Pittsburgh, Pa.) Describes and illustrates bins and measuring equipment for proportioning concrete aggregates, cement and water. Complete ready-mixed concrete plants and truck-mixing and agitating bodies are also shown.

Cars, Automatic

Automatic and Remote Control Cars. 12 p. (Bull. No. 1239. The Atlas Car & Manufacturing Co., Cleveland, O.) Describes and illustrates a system of remote-control quarry cars, showing their application at a Texas cement-plant quarry. Other automatic cars for standard rail and narrow-gauge systems are also shown.

Car Wheels

S & D 10-Year Wheel. 4 p. (Sanford-Day Iron Works, Inc., Knoxville, Tenn.) Describes and illustrates a new wheel for quarry cars. Features include roller bearing construction, operation for one year with one lubrication, low first cost, low maintenance, and a 10-year service guarantee.

Conveyors, Belt

Concrete Handling. 48 p. (Barber-Greene Co., Aurora, Ill.) Describes and illustrates the use of belt conveyors for handling wet concrete in a variety of construction jobs. Also contains engineering data on the light- and heavy-duty type of conveyors.

Crushers

Sledge-Wedge Crushers. 8 p. (Cat. No. C-95. McLanahan & Stone Corp., Hollidaysburg, Pa.) Describes and illustrates a crusher employing a combined impact, squeeze and wedge-splitting action for the reduction of stone and other materials.

Drill Sharpeners

Sullivan Light Model Drill Sharpener. 16 p. (Bull. No. 72-N. Sullivan Machinery Co., Chicago, Ill.) Describes and illustrates an all-hammer light drill sharpener classified as the Type C. A heavy-duty Model, Type A, is described in the company's 32-page Bulletin 72-J.

Dump-Truck Bodies

"Commercial" Dump Bodies and Hydraulic Hoists. 6 p. (Bull. No. 102. The Commercial Shearing & Stamping Co., Youngstown, O.) Describes and illustrates a line of pressed-steel rear-dump bodies, three-way dump bodies and hydraulic hoist for the light truck chassis made by this concern.

Locomotives, Gasoline

Plymouth Gasoline Locomotives—Model TLF. 12 p. (The Fate-Root-Heath Co., Plymouth, O.) Describes and illustrates a new industrial locomotive in sizes from 2½ to 4 tons, powered with a standard Ford engine and equipped with a 4-speed truck transmission.

Pipe Fittings

Dayton Pipe-Line Requirements. 64 p. (The Dayton Pipe Coupling Co., Dayton, O.) Describes and illustrates a complete line of couplings, sleeves, clamps, saddles and other fittings for industrial pipe-lines.

Pulverizers

The Whiting Table-Roller Pulverizer. 8 p. (Bull. No. 12. Grindle Fuel Equipment Co., subsidiary of Whiting Corp., Harvey, Ill.) Describes and illustrates an improved Bethlehem pulverizer of low power consumption, adjustable grinding pressure, producing uniform fineness with slow-speed operation.

Screens

Sizing Screens. 8 p. (McLanahan & Stone Corp., Hollidaysburg, Pa.) Describes and illustrates a line of sizing screens in rotary, jacketed and shaking types, as well as combined scrubbing and washing models.

Wire Rope

Roebling Wire Rope and Wire. 280 p. (John A. Roeblings' Sons Co., Trenton, N. J.) A well-bound catalogue of wire rope, wire and fittings. Contains valuable chapters such as "Proper Working Loads for Wire Rope," "Modern Excavating Equipment," "Proper Sizes of Sheaves and Drums," etc.

Miscellaneous

How to Deaden Machine Vibrations and Noise. 4 p. (L. Mundet & Son, Inc., New York, N. Y.) Describes and illustrates a natural cork mat for machinery bases to eliminate vibrations and deaden operation sounds.

Tannergas. 4 p. (Bull. 2170. Sullivan Machinery Co., Chicago, Ill.) Describes and illustrates a patented gas confined in pressure tanks for use in connection with compressed-air lines to prevent freezing at temperatures as low as 40 deg. below zero.

Adopts Trade-Practice Rules of Mixer Builders

Trade-practice-conference rules for guidance of the manufacturers of concrete-mixers and pavers, originally proposed at a conference with Federal Trade Commission officials at French Lick Springs, Ind., Sept. 5, 1929, but subsequently modified by the commission, have been adopted by a committee representing the industry, the commission has announced.

As is customary with trade-practice rules, those for the concrete-mixer and paver industries are divided into two groups. The Group I rules relate to matters which are violations of the law, such as false advertisement of grade, quality, or quantity of products; sale of any product by false means or device; defamation of competitors; false disparagement of grade or quality of the goods of competitors; maliciously enticing away employees of competitors, and a number of others.

The Group II rules, which are accepted as expressions of the trade, pertain to independent publication of price lists and making terms of sale a part of published price schedules; accurate methods of determining cost; and a committee on trade practices to coöperate with the commission.

The commission declined to approve or accept rules 13, 14, 16, 17 and 18, all in Group II, and rules 8, 9, and 17, which were adopted by the industries and published Nov. 21, 1929.

As originally proposed by the industries following the French Lick Springs conference, there were 22 rules, but as finally approved by the commission these were cut to 13, of which 10 were Group I and 3 Group II rules.

From the standpoint of the industries the Group II rules probably are more important, for they represent agreements between members of the industries, whereas the Group I rules embody points covered by law and which they would be compelled to obey whether they were approved or not.

The first of the Group II rules, known as Rule A, accepted by the commission, reads as follows:

(a) The industry approves the practice of each individual member of the industry independently publishing and circulating to the purchasing trade its own price lists.

(b) The industry approves the practice of making the terms of sale a part of all published price schedules.

Rule B provides that "it is the judgment of the industry that each member should install a proper and accurate method for determining his cost."

Rule C creates a committee on trade practices "to coöperate with the Federal Trade Commission and to perform such acts as may be proper to put these rules into effect."

In addition to those already enumerated, the Group I rules cover the practices of maliciously inducing or attempting to induce breach of existing contracts between competitors and their customers; secret payment of rebates; giving money or anything of value to representatives of customers or of competitors' customers without the knowledge of their employers; discrimination in price between different purchasers of commodities.

New Machinery and Supplies

Clam-Shell Bucket Has Numerous Improvements

The new type N clam-shell bucket announced by the Jos. F. Kiesler Co., 928 W. Huron St., Chicago, is improved in design and construction, employing many of the well-known Kiesler features, to which have been added the redesigned double-fulcrum digging arms, shells, cutting edges, and teeth.

The improved clam-shell bucket.

A feature of this bucket is the correct design which enables it to penetrate freely and dump sticky materials quickly. There are no obstructions on the inside of the shells. All parts are built extra heavy for continuous service and long life. No dead weight is built into the bucket.

Manganese-Steel Feeder Built for Heavy Service

Bulk-material handling has been highly developed by the introduction of many interesting and ingenious devices or machines and a constant and successful effort has been made toward improved designs. One phase of the problem is the moving of bulk material such as ore, rock, gravel and the like from bins. Ordinarily some form of gate, either with or without a conveyor belt, answers satisfactorily. However, in those cases where a uniform flow or discharge to a crusher, for example, is required but difficult to obtain, some form of automatic feeder is demanded and of these the apron or pan is the common type. Gravel may usually be classified as minus 12 in. and shovel quarry rock may usually be classified as plus 12 in. Therefore, apron or pan feeders may likewise be divided into two general classes—light and heavy. The desirable feeder is the one which operates through the maximum period of time without interruption and replacements and at the lowest cost (including investment and operating expense) per ton of material handled. Some years ago the American Manganese Steel Co. started to develop such a feeder and several hundred installations of all sizes operating over a long period of time throughout the world have proved the design. The AMSCO feeder is all manganese steel with the following major features of design:

Smooth apron surface, with a floor and side-flange overlap which prevent fouling, leakage and spillage. Chains with one-piece links, liberal pin surface, and knee-type joints which prevent sagging between the supporting track wheels. No chain wear except when rounding the drive sprocket. No rollers in the chain. No lubrication of chain parts. No operating attention except for lubrication of the shaft bearings. No floor shovel cleaning of leaks and spills.

With the application of the power shovel and the use of large primary breakers, there properly has arisen the need for a feeder to handle large rocks up to 4 or 5 tons in weight. The old practice of dumping a pit car carrying up to 40 tons into a crusher is usually a source of train delay in waiting for the crusher and there is always the hazard of blocking the crusher opening with consequent loss of time in digging out.

The use of a feeder enables a train to dump quickly into a bin and to return to the pit. The crusher operator runs the feeder, so that the crusher is working on an even feed at full capacity but is never hurried. Of course, a steady feed to any machine is a more efficient operation than an intermittent feed. An oversized rock is easily seen and the feeder is stopped for its removal.

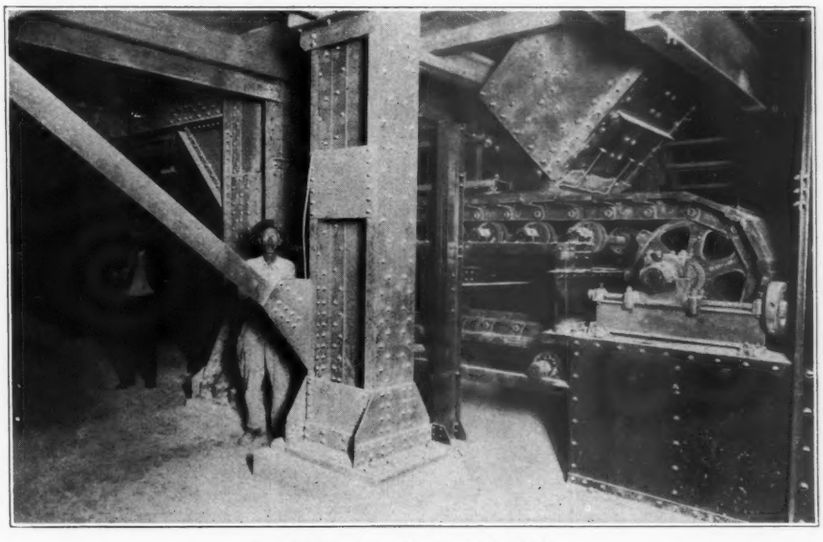
Such feeder service is indeed severe and the best in material and design is required. There are several AMSCO installations working successfully in such service. An outstanding example is an 8-ft. by 72-ft. feeder at an angle of 18 deg., which has been operating for over 3½ years at 900 tons per hr., or about 8,000 tons per day. It handles material which is mined by shovels with 4-yard dippers and contains a rather high percentage of pieces weighing from 1 to 5 tons. There is no appreciable wear, there have been no repairs, the operation is clean, and no attention is required except for lubrication of the shafting. The indicating wattmeter shows a uniform power input of 30 kw. and the power per ton amounts to 0.03 kw.-hr. The bin has nothing more than a plain throat of ample size and no jamming occurs.

Amsco Feeders are made in sizes to fit all conditions, from 2 ft. to 8½ ft. in width. Manganese parts are engineered and furnished by the American Manganese Steel Co. and complete installations are engineered and furnished by the Stephens-Adamson Mfg. Co.

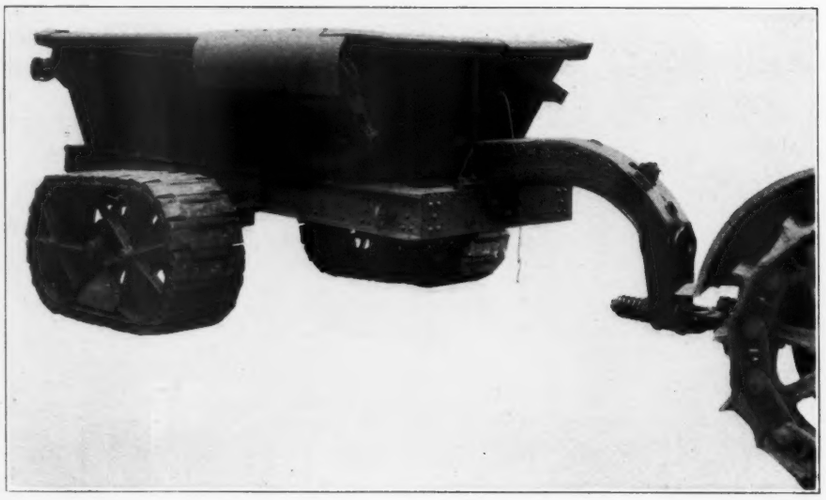
Crawler-Mounted Wagon Built Entirely of Steel

The LaPlant-Choate wagon has been developed to meet the requirements of speedy and efficient operation combined with strength and long life.

Designed to carry between 7 and 8 cu.yd. of material, the "Roadlayer" wagon is built entirely of steel, hot riveting and electric welding being used throughout. The frame is constructed of heavy-section channels riveted and electric welded.



Installation view of one of the feeders.



All-steel dump wagon on crawlers.

There are many features which are distinct advantages. The absence of wheels in front prevents miring, reduces the drawbar pull required, and eliminates "jack-knifing." The tracks on the wagon follow directly in the path of the tractor tracks.

The wagons may be obtained with or without flareboard for use with shovel-loading outfits. This flareboard gives extra carrying capacity, and is quickly attached or removed as needed.

A cast-steel box is provided at the rear of the wagon through which the rear drawbar is fastened. The pull-bar casting on the rear is the same as used at the front.

The box casting is bolted to the rear wagon cross-tie by four ⅞ in. bolts and to each channel beam by five ⅞ in. bolts, making 14 bolts in all.

The handwind for the DW-7 has combined as an integral part of the winding drum and the trip ratchet. By combining these in one casting the usual strain for winding up the wagon and for carrying the load is not carried from the shaft. There is no twist in the shaft whatsoever due to carrying the load, as this weight is carried directly to the Hyatt bearings.

A simple swivel-type step is provided on the left side, so attached that it will fold up under the wagon body when obstructions are hit. The step is made like an open grate so that it will clean itself of mud.

The dump wagon is one of the newer products manufactured by the LaPlant-Choate Manufacturing Co. of Cedar Rapids, Ia.

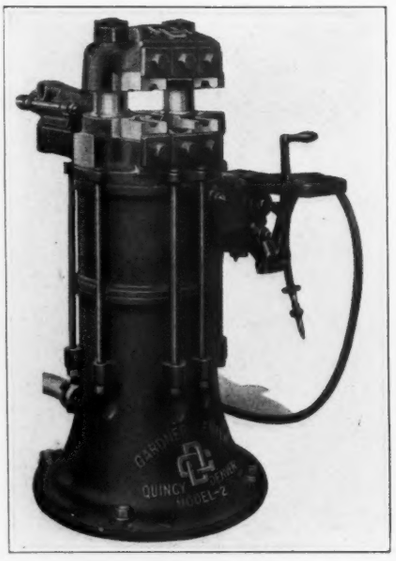
New Sharpener for Drill Steel, Stoper Developed

The new DS-2 Gardner-Denver sharpener is the ideal small drill-steel sharpener for quarries using hand drills. The machine is operated with two die pistons in tandem. Both are used for clamping and upsetting. One piston only is used for fullering and gauging. This improved design results in unusually low air consumption and longer life.

A single throttle valve controls the fullering, clamping, and dollying operations. This lever is conveniently placed at the side of the machine, and its movement is so smooth and easy that there is little or no fatigue for the operator.

This sharpener, the bare weight of which is 1,370 lb., is designed to handle steel in cross section up to 1⅛ in. and to make bits having a maximum diameter of 2½ in. Standard four-point cross bits, six point bits, and McLellan-type bits are made with regular equipment.

Another new Gardner-Denver development is the Model H-81 hand-rotated stoper, in which the hammer is of single diameter, reversible-block-type construction, insuring long life and low cost. The tubular automatic valve is located in the back of the cylinder, which gives the machine a smooth exterior. The bearing surfaces are ample, and the efficiency is high.



Light weight drill sharpener.

Side rods on the H-81 Stoper are designed so that the air feed cylinder can be removed without distributing the assembly of the other parts of the drill, thus providing a quick and easy method of changing the water tube.

The feed piston has one cup rubber in place of two cup leathers, and the head of the piston is surrounded by a long brass follower, which is renewable and prevents the whip of the machine on the air feed. This prevents wear on these parts and reduces upkeep costs.

The hand-rotated stoper.

The machine is constructed throughout of drop forgings and especially selected alloy steel properly heat treated to insure low cost.

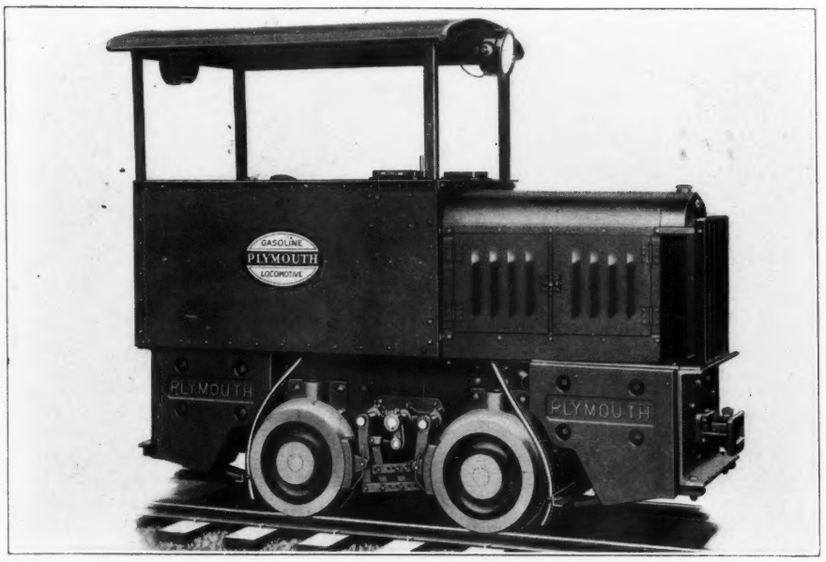
New Gasoline Locomotive Powered by Ford Engine

To meet the requirements of those having a light haulage problem, a new model gasoline locomotive equipped with Ford engine and 4-speed truck transmission has been announced by The Fate-Root-Heath Co. (Plymouth Locomotive Works), Plymouth, O.

Built in four weights—2½, 3, 3½ and 4-tons—on a short wheel base to negotiate sharp curves and with abundant power, it makes an ideal unit for quarries, sand, gravel and clay plants and general industrial haulage.

A Plymouth reversing transmission, connected by a shaft and universal joints to the Ford 4-speed truck transmission, provides four speeds in either direction.

The side frames, bumpers and cross supports are of heavy structural and bar steel, well braced and rigidly riv-



New gasoline locomotive using standard 4-cylinder engine.

eted and welded together, making a very strong frame.

The large, roomy cab gives clear vision in all directions. Standard equipment provides electric starter, generator, headlights, horn and oil-moistened air cleaner.

An illustrated 12 page Bulletin has been issued giving a complete, detailed description of the locomotive.

Any Speed Possible in New Type Transmission

The American Engineering Co. of Philadelphia announces the introduction of a small, very compact 5-hp. electro-hydraulic transmission. The transmission will develop full rated torque at any speed, whether it be 1 r.p.m. or 1,000 r.p.m. Since the torque is constant the horsepower output varies with the speed of the hydraulic motor. At maximum speed the transmission will develop 5 hp. continuously.

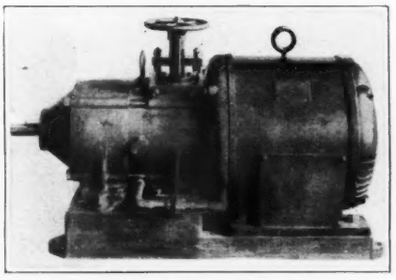
In the accompanying picture the hydraulic motor is at the left, hydraulic pump next to it in the middle, and electric motor at the right. They are all mounted on a single bed plate reservoir which contains the oil used in the system. The entire transmission, including motor, is only 30 in. long, 14 in. wide and 16 in. high.

The hydraulic pump and motor are of the Hele-Shaw design and are similar in construction except that the motor has a fixed stroke while the stroke of the pump may be varied from minimum to maximum.

Pump and motor are multi-cylindered and handle the fluid in a smooth, continuous stream.

The electric motor drives the pump shaft at a constant speed. Oil is delivered by the pump to the hydraulic motor at a rate corresponding to the stroke of the pump, regulated by the hand wheel shown, or any other desirable hand or automatic control. This is the only point of regulation for there are no controls on the electric or hydraulic motors. Through the handwheel the speed of the hydraulic motor can be varied all the way from zero to maximum in either a forward or reverse direction.

The pump end of the electric motor



An electro-hydraulic transmission.

shaft is fitted with a fan. Oil in the system passes through finned tubing surrounding the fan, consequently its temperature is maintained at a degree commensurate with efficient operation.

Use of Aluminum Cuts Car Weight 35 Per Cent.

An experimental all-aluminum mine and quarry car has been built recently by the Watt Car & Wheel Co. at Barnesville, O. Aluminum sheets and forms, patterned after a steel car which the Watt Car & Wheel Co. has been building for some time, were furnished by the Aluminum Co. of America. This duplication of design will furnish a good opportunity for making observations as to the performance of the new car in operation.

The aluminum car weighs 2,040 lb. and the steel car tips the scales at 3,100 lb. The difference of 1,060 lb. in weight is expected to demonstrate that the new all-aluminum mining car can more than pay for itself by the saving in motive power alone.

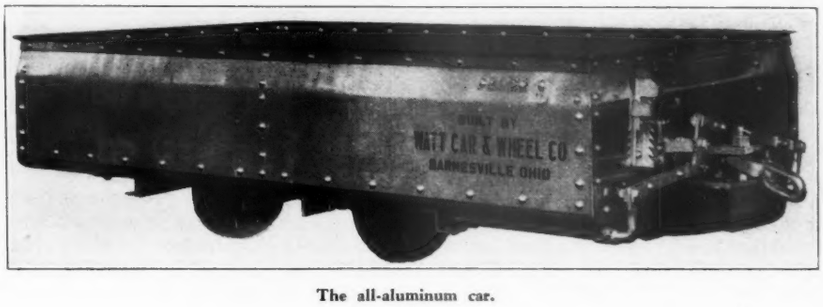
Tension Indicator Gives Line Loads of Wire Rope

A simple, light-weight instrument for obtaining the line loads on cranes, buckets, shovels, guys and derricks has been developed and made available recently by the Martin-Decker Corp., Long Beach, Cal. The device is also used for testing the holding power of deadmen and anchors, hoists, and elevator cables, and in other industrial and engineering operations where the exact strain on a wire line or cable is desired in terms of pounds.

The standard tension indicator as designed for general purposes is a smaller edition of the instrument that has been universally used in the petroleum industry for measuring loads on drilling lines. The tension indicator may be applied to the cable and the load read, and removed in less than a minute's time. Provision is made for temperature adjustments when close accuracy is required.

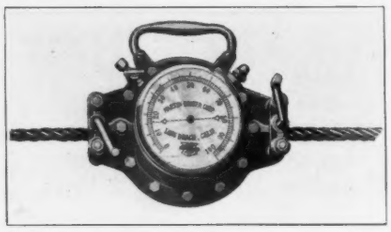
In operation, the tension indicator is clamped directly on to the cable span, measuring the load by the deflection principle without dead-ending or taking up slack. A definite off-set is made in the line between two fixed points and the force required to make or maintain this off-set is shown on the gauge, a direct indication of the line load. It may be applied to the cable while already under load, prior to the application of the stress, or during changes of the load, and will accurately register the tension at all times. Using a calibrated line, any pulling load may be measured.

In construction, the tension indicator comprises two adjustable clamps one at each end which bring the line to a fixed stop. Between these clamps



The all-aluminum car.

a pressure plate is fitted with a projection which attains the line off-set. This pressure plate bears against a flexible, canvas re-inforced rubber diaphragm backed up by a body of fluid. The fluid pressure generated is a positive measure of the force required to maintain the off-set in the



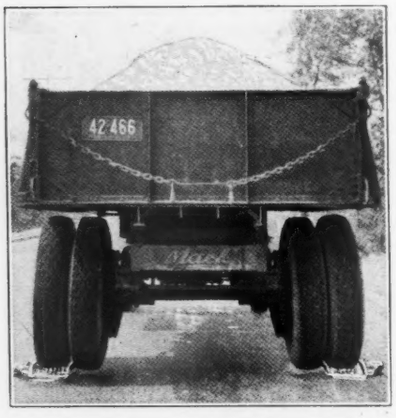
Device for measuring tension on cables.

line, and is indicated on the gauge. It can be directly transposed into actual pounds tension on the cable.

The indicator is available in two sizes, the standard model measuring loads on any wire line between ¼-in. and ¾-in. diameter, up to 16,000 lb. The heavy-duty model measures lines from ¾-in. to 2⅜-in. diameter, up to 260,000 lb. There are no delicate parts to become deranged and no special skill or training is required to use the instrument.

Device Measures Weight of Trucks and Trailers

The Black & Decker Manufacturing Co., Towson, Md., has just announced an improved model Loadometer for measuring the loaded weight of trucks, trailers, and tractors. It is



How the truck scales are used.

used principally in the enforcement of existing weight laws governing the use of motor vehicles on highways and streets, but may be used anywhere when the weight of a vehicle is desired. Known as the Turtle-Back Drive-On Loadometer, it is reported to be more accurate than any previous type. The "turtle-back" type of platform completely covers all the mechanism. No dust, moisture, water, tar, mud or foreign matter of any kind can reach the operating parts, thus assuring accuracy and years of efficient service.

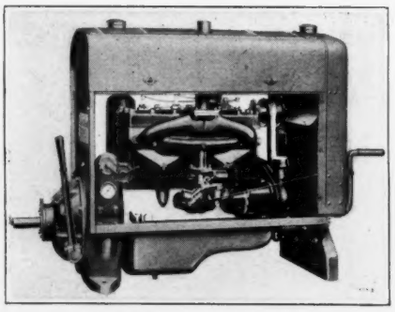
Two cams support the platform and hold it above the mechanism until the wheel comes to rest on the platform. This method of controlling the wheel load insures accuracy by preventing transmission of wheel impact or thrust to the recording mechanism. Further, the inclined ramps are an integral part of the weighing platform, thereby making it possible to accommodate the large balloon tires now being used. In this connection, it is pointed out that the large platform will easily accommodate the largest balloon tire as well as any size of solid tire.

The Loadometer is made of a heat-treated aluminum alloy, giving maximum strength with minimum weight. The complete outfit consists of two Loadometers packed in a handy carrying case. They are furnished in load capacities of 7,000 lb., 15,000 lb., 20,000 lb., 3,500 kg., 7,000 kg., and 7 long tons.

Small Gasoline Engines Rated at 10 to 25 Hp.

The Waukesha Motor Co. manufacturers of heavy-duty internal-combustion engines has entered a new field in the industrial engine market by the manufacture of a series of two small four-cylinder engines of 10-hp. to 20-hp. size. Formerly, engines under 20-25 hp. were not available but with the addition of the FLJ and FKJ, known as the "agile fours," this company is stepping squarely into the center of a new market.

These smallest Waukesha engines have all the ear-marks of their bigger brothers. They have the standard Ricardo combustion chamber, short, stiff crankshaft supported by three unusually large, bronze backed replaceable bearings, full pressure oiling,



Small industrial power unit.

built in governor and detachable flywheel housing. In addition to these standard and typical Waukesha features, there is an unusual degree of flexibility in the facility for mounting accessories. It is possible to install a full series-type oil filter, complete electric-starting and lighting system, three-point suspension, either battery or magneto ignition, all of which are available and add greatly to the popular appeal of this engine.

The full-pressure oiling system with drilled crankshaft and outside pressure adjustment is not commonly found in engines as small as these. The oil is distributed by a positively driven gear pump submerged in the oil reservoir and surrounded by the Waukesha oil-level equalizer. This feature insures a positive supply of oil under full pressure at all levels and temperatures.

In addition to this, a complete self contained power unit can be had that lends itself to many handy uses. Bolted to a pair of 4 in. by 4 in. skids, it may be moved from place to place easily, and quickly set to work the same as an electric motor. The power take-off is entirely enclosed.

Weight of Motor Maintains Tension in New Short-Center Drive

By J. R. HOPKINS
American Leather Belting Assn.

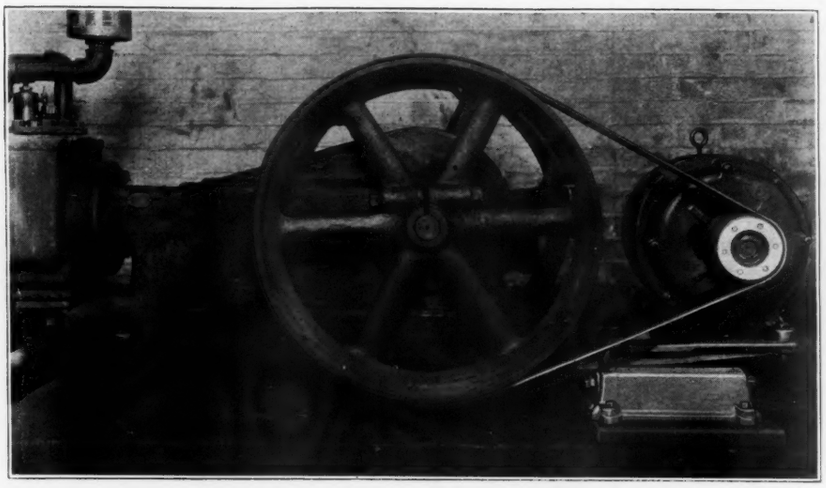
Leather belts are still largely used on regular long center belt drives. However, when short-center driving became so much in demand the leather belt failed to hold its place in the picture. The engineer and plant operator did not seem to realize that he could operate flat belts successfully. One of the difficulties was in maintaining a proper belt tension (as the lengths of the short center belts are not very long, in fact are rather short) and atmospheric and gradual elongation of the belt required rather a fine and frequent adjustment. Until the Rockwood short-center leather-belt drive was developed this has been apparently rather difficult.

However, if one can conceivably set up a condition so that proper belt tension can be maintained with a flat leather-belt drive on short centers a very satisfactory band drive may be had. All belt tests show that. Practical experience has demonstrated it.

All that has literally been done in the new Rockwood short-center drive which utilizes the weight of the motor which is already on the job and using it by a proper location of the motor on a pivot to maintain a known, prescribed belt tension at all speed changes.

The drive itself consists of a base for mounting the motor on the proper location of pivot point. A scheme has been engineered whereby any motor, regardless of size, type or weight, can be so placed on the pivoted arms that it will set up whatever tension is required by a belt of a specified thickness, width and construction.

The Rockwood Drive has an interesting history. The first drives were made and installed over seven years ago, most of them being still in serv-



Short-center drive on single-stage air compressor. Motor pulley 5¼ in. Driven pulley 28 in.

ice. About 150 of these drives have been in service for four continuous years with satisfactory results. The drive, however, was not formally placed on the market in its present form until this spring.

As the leather belt is a necessary part of each drive and as the drives are sold as complete driving units with the full responsibility for successful operation on the shoulders of the sellers, the manufacturers of leather belting, individually and through the American Leather Belting Assn., have worked with and cooperated with Rockwood engineers in developing belt standards best adapted for short center driving.

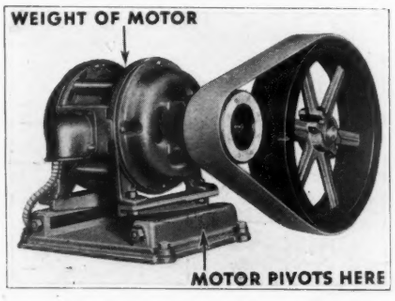
The American Leather Belting Assn., some time ago authorized a series of comprehensive tests made at Cornell University in which Rockwood Drives were tested in conjunction with other short center drives. The Rockwood Drive showed an efficiency of 99 per cent. and over and this efficiency is said not to decrease with use. The transmission capacity was in keeping with the best capacities of leather belting. The belt slip was less than 1 per cent. at rated capacity and not over 1 per cent at 50 per cent. overload.

One of the features interesting to maintenance men and erection crews is the ease with which the drive can be installed. Four bolts hold the base to the floor and four more bolt the motor to the base. Adjusting screws make it possible to bring the motor pulley into alignment with the driven pulley in a few minutes with a few turns of a wrench.

The flat endless leather belt can be installed endless on the job where necessary and the machinery never has to be dismantled. Even if the belt has considerable stretch the belt never has to be taken up as there is more than enough allowance in the base for any possible belt elongation.

The drive is unique in that it is the only short center drive where the center distance is not fixed. The center distance changes with the changing belt lengths. When the drive is at rest the belt tension is so slight that the belt is permitted to come back and rest.

As the belt tensions are known and controlled and as the engineering is so carefully worked out, bearing pressures on the motor bearings are very low. This results in low power consumption, many drives are reported as having paid for themselves by savings in power consumption alone. The leather belt assists the drive to handle jerk loads and shock loads very smoothly.



Explanatory view of the drive.

Standard stock bases come in six sizes. These six sizes fit all motors from 1 to 50 hp., 1800 r.p.m. Larger sizes up to 500 hp. are made to order of welded steel in about a week's time.

Asbestos Conveyor Belt Used for Hot Materials

A conveyor belt with an asbestos surface is being placed on the market by Bell's Asbestos & Engineering Supplies, Ltd., of Slough, England, and English patents have been issued to that firm.

The belt is a combination of asbestos, duck and rubber, the asbestos cloth surface being particularly desirable where hot material is carried, as in the conveying of hot clinker in cement plants. The ordinary rubber-surface conveyor belting does not satisfactorily withstand the action of such hot material.

While this belt is still somewhat in the experimental stage, four of them have been sold for practical use, one having been in use for eight months, and up to date they are all said to be giving satisfactory results.

Recent Patents

(*Continued from page 72*)

Settling apparatus for the separation of solid and liquid matters. C. Still. British 348,888.

Screening apparatus. R. Haddan (Royer Foundry & Machine Co.). British 349,245.

Method of and apparatus for imparting a reciprocatory movement to a screen for screening materials or like apparatus. M. P. Reynolds. British 349,560.

Magnetic separators. Spencer (Melksham), Ltd., and M. W. Clark. British 349,564.

Screening-apparatus. Underfeed Stoker Co., Ltd., and G. H. Strain. British 349,481.

Vibrating sieves. Comebra Soc. Anon. British 349,868.

Apparatus for removing solid particles from liquids. Dorr Co. British 349,473.

Air separator. Claudius Peters, Hamburg. German 531,445.

Portable dust separator. Maschinenfabrik Beth, Akt.-Ges., Lubeck. German 531,565.

Apparatus for separating granular materials. Joseph C. Pearson, Allentown, Pa., and Frank A. Hitchcock, Washington, D. C. Canadian 314,099.

Screening apparatus. The W. S. Tyler Co., Cleveland, assignee of Morley Punshon Reynolds, Cleveland Heights, Ohio. Canadian 314,435.

Worthington, Metalweld Combine Is Announced

The Worthington Pump & Machinery Corp. has acquired the manufacturing and marketing facilities of Metalweld, Inc., Philadelphia, Pa., builders of a complete line of portable compressor units. For many years Worthington has been a leader in the compressor industry. Last year it took over the manufacture and sale of Gilman rock drills and accessories. This, together with the added line of portable and semi-portable compressors and other tools, will enable Worthington to supply all air equipment requirements.

Worthington feather-valve compressors always have been an integral part of Metalweld portable units. It is a natural step, therefore, for Worthington to acquire the manufacture of the complete product. The portable compressors will be manufactured at the Harrison, N. J., works of the Worthington Pump & Machinery Corp., and the engineering, manufacturing and sales personnel of the Metalweld organization also will be located there.

Improved Ribs . . .

These improved belt plates have ribs shaped to make the extraction of rivets easy. The plates conform to the circumference of the pulley, and will not cut the belt. Each plate is marked for centering. Only tough, cold-rolled steel is used. Bristol's rivets have sharpened, self-clinching points. Their beveled heads are easy to hold when extracting. Made of cadmium plated steel to resist rust.

Write for Bulletin 715-O

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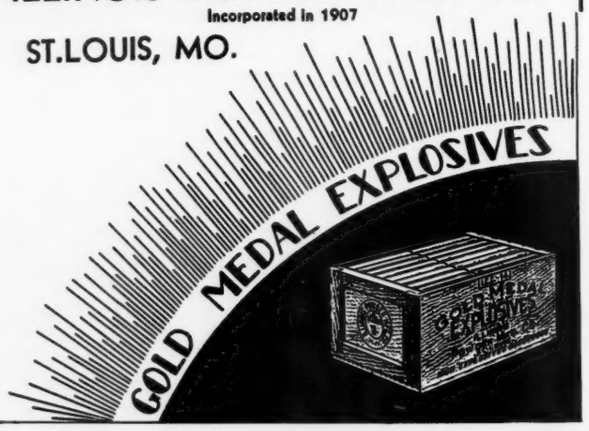

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ONE PUMP - - - - does the work of two - - SAVES $12,500.00

ON a certain job in the Mississippi River, a dredging company has one ordinary dredge pump, capable of 125 cubic yards of fill per hour at 100′ head, the pump being driven by a 550 H. P. motor. The requirements of the fill demanded 200 additional foot of pumping head, which would ordinarily mean the installation of two booster pumps. They investigated the Hydroseal Pump and found that with one pump, driven by a 500 H. P. motor, they could obtain the required additional head with the same pumping capacity.

By using the Hydroseal Pump they save 50 H. P. on one pump and 550 H. P. on the second booster pump or 600 H. P. per hour. At 1c per hour per H. P., the saving is $6.00 plus $1.25 per hour for an attendant at the second booster or a total of $7.25 per hour. Their contract covers 250,000 cubic yards of fill, and since they save $7.25 for every 125 yards of fill, they save over 5c per cubic yard or a total of $12,500.00 on the job. Aside from this, they save the cost of a second booster pump, a 550 H. P. motor and about 2500 feet of electric cable, which would have been necessary therefor.

Write us for the name of the dredging company making this saving, a list of Hydroseal Pump installations and our Catalog 331. The Allen Sherman Hoff Co., 215 So. 15th St., Philadelphia.

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